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THE JOINT US/UK 1990 EPOCH WORLD MAGNETIC MODEL

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FOREWORD

As it has in centuries past, the Earth's magnetic field still plays a vital role in global navigation. All navigational aids or attitude/heading reference systems (AHRS), regardless of their operating principles, must speak a common language. That common language is in terms of the Earth's magnetic declination. Consequently, magnetic-related navigational aids are integrated, in the form of computer hardware and software, into virtually every major weapons system of the Army, Air Force, Navy, and Marines. In order to maintain optimum performance, these systems must be periodically updated with regard to the Earth's magnetic field, which is a dynamic entity that changes slowly but erratically with time.

For well over a century, it has been the responsibility of the U.S. Naval Oceanographic Office to monitor the Earth's changing magnetic field and periodically report on these changes in the form of magnetic charts and mathematical models. For the past forty years, this task has involved an intensive data collection effort through the Project MAGNET program, which in April 1990 made the transition from primarily aeromagnetic surveying to satellite surveying with the launch of the Polar Orbiting Geomagnetic Survey (POGS) satellite. Follow-on satellite missions to secure data for future needs, well into the twenty-first century, are now being vigorously pursued.

This report is a comprehensive summary of the cooperative effort between the U.S. Naval Oceanographic Office and the British Geological Survey in producing the 1990 Epoch World Magnetic Model, WMM-90.

ROBERT Y. FELT
Captain, U.S. Navy
Commanding Officer

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A detailed summary of the data used, analyses performed, modeling techniques employed, and results obtained in the course of the 1990 Epoch World Magnetic Modeling effort are given. Also, use and limitations of the GEOMAG algorithm are presented. Charts and tables related to the 1990 World Magnetic Model (WMM-90) for the Earth's main field and secular variation in Mercator and polar stereographic projections are presented along with useful tables of several magnetic field components and their secular variation on a 5-degree worldwide grid.

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SECTION 1. THE GEOMAG ALGORITHM AND THE 1990 MODEL

1.0 Introduction

The Earth's magnetic field, as measured by a magnetic sensor on or above the Earth's surface, is actually a composite of several magnetic fields generated by a variety of sources, which are superimposed on each other and which interact with each other. The most important of these geomagnetic sources are:

a. the Earth's fluid outer core;
b. the Earth's crust/upper mantle;
c. the ionosphere; and
d. the magnetosphere.

The magnetic variation algorithm (GEOMAG) is a Fortran subroutine which is based on a spherical harmonic expansion of the Earth's magnetic field, the coefficients of which comprise the World Magnetic Model (WMM). These coefficients are produced jointly by the U.S. Naval Oceanographic Office (NAVOCEANO)'s Geopotential Division and the British Geological Survey (BGS). The WMM is distributed by NAVOCEANO for the Defense Mapping Agency (DMA) in accordance with DMA Instructions 8000.1 and 8000.2. The WMMs are usually produced at 5-year intervals and are composed of two parts: a main field model, which describes the Earth's magnetic field at some base epoch, and a secular variation model, which accounts for the slow temporal variations in the main geomagnetic field from the base epoch to a maximum of 5 years beyond the base epoch. For example, the base epoch of the WMM-90 magnetic field model is 1990.0. This model is therefore considered valid between 1990.0 and 1995.0 and will subsequently be replaced at 1995.0 by the WMM-95 magnetic field model.

It is extremely important to recognize that the WMM series of geomagnetic models and the charts produced from these models characterize only that portion of the Earth's magnetic field which is generated by the Earth's fluid outer core. The portions of the geomagnetic field generated by the Earth's crust, mantle, ionosphere, and magnetosphere are not represented in these models. Consequently, a magnetic sensor such as a compass or magnetometer may observe spatial and temporal magnetic anomalies when referenced to the appropriate WMM. In particular, certain local, regional, and temporal magnetic declination anomalies can exceed 10 degrees. Anomalies of this magnitude are not common, but they do exist. Declination anomalies on the order of 3 or 4 degrees are not uncommon, but are of small spatial extent and relatively isolated. On land, spatial anomalies are produced by mountain ranges; ore deposits; ground which has been struck by lightning; geological faults; and cultural features such as trains, planes, tanks, railroad tracks, power lines, etc. In ocean areas, spatial anomalies are produced by continental margins, seamounts, oceanic ridges, trenches and fault zones, and ships and submarines. Temporal anomalies in either ocean or land areas can last from a few minutes to several days and are produced by ionospheric and magnetospheric processes which are driven by the solar wind.

Magnetic storms in particular can cause severe and persistent magnetic anomalies. Even in periods of quiet solar activity, significant spatial and temporal magnetic anomalies are found in the polar and equatorial regions of the Earth, where magnetic fields produced by ionospheric current systems, such as the auroral electrojets and the equatorial electrojet, are always present. Most of the possible sources of magnetic anomalies are comparatively isolated in either space or time. Therefore, from a global perspective, the root-mean-square (RMS), declination (DEC), and inclination (DIP) errors at sea level of the WMM are estimated to be less than 0.5 degrees in ocean areas and less than 1.0 degrees in land areas at the Earth's surface over the entire 5-year life of a particular model. Also, the RMS errors at sea level of the horizontal (H) and total intensity (F) components of the WMM over ocean and land areas are estimated to be less than 200 nanoteslas (nT) over the entire 5-year life of the models.

1.1 The Mathematical Model

The Earth's magnetic field has associated with it a geomagnetic potential $V(r,\theta,\phi,\tau)$, which can be expressed in spherical coordinates in terms of a spherical harmonic expansion of the following form:

$$V(r,\theta,\phi,\tau) = R_E \sum_{n=1}^{N}\left(\frac{R_E}{r}\right)^{n+1} \sum_{m=0}^{n}\{g_{nm}(\tau)\cos m\phi + h_{nm}(\tau)\sin m\phi\}P_n^m(\theta) \tag{1}$$

where the spherical coordinates (r,θ,ϕ) correspond to the radius from the center of the Earth, the colatitude (i.e., 90° - latitude), and the longitude. R_E is the mean radius of the Earth; $g_{nm}(\tau)$ and $h_{nm}(\tau)$ are referred to as the Gauss coefficients at time τ, where τ is the time in years (e.g., 1987.312). $P_n^m(\theta)$ represents a particular associated Legendre polynomial of degree n and order m. These polynomials are functions of the colatitude θ. The Gauss coefficients are slowly varying functions of time and are expressed in the form:

$$g_{nm}(\tau) = g_{nm}(T_{EPOCH}) + \dot{g}_{nm}(\tau - T_{EPOCH}) \tag{2a}$$

$$h_{nm}(\tau) = h_{nm}(T_{EPOCH}) + \dot{h}_{nm}(\tau - T_{EPOCH}) \tag{2b}$$

where T_{EPOCH} is the base epoch of the model, which for WMM-90 is 1990.0. Thus, $g_{nm}(T_{EPOCH})$ and $h_{nm}(T_{EPOCH})$ are the Gauss coefficients of the WMM at the model's base epoch, while $\dot{g}_{nm}$ and $\dot{h}_{nm}$ (pronounced g_{nm} dot and h_{nm} dot) are the annual rates of change of the Gauss coefficients. The Gauss coefficients $g_{nm}(T_{EPOCH})$ and $h_{nm}(T_{EPOCH})$ and their annual rates of change are spherical harmonic coefficients. The Gauss coefficients $g_{nm}(T_{EPOCH})$ and $h_{nm}(T_{EPOCH})$ characterize the Earth's main magnetic field at the base epoch of the model, T_{EPOCH}, while $\dot{g}_{nm}$ and $\dot{h}_{nm}$ characterize the

secular change of the Earth's main magnetic field during the 5-year life of the model. These coefficients, up to degree and order 12 for the main field and up to degree and order 8 for the secular variation of the main field, comprise the WMM. Currently, the secular variation model from degree 8 through degree 12 is padded with zeros.

The Earth's magnetic field $\vec{B}(r,\theta,\phi,\tau)$ is a vector quantity having three components which correspond to the projection of the magnetic field vector onto the three coordinate axes. Thus, $B_r(r,\theta,\phi,\tau)$ is that portion of the field pointing in the radial direction (i.e., perpendicular to the surface of the Earth), $B_\theta(r,\theta,\phi,\tau)$ is that portion of the field pointing locally due south, and $B_\phi(r,\theta,\phi,\tau)$ is that portion of the field pointing locally due east. The magnetic field vector can be computed from the geomagnetic potential by taking its gradient, thus:

$$\vec{B}(r,\theta,\phi,\tau) = -\vec{\nabla}V(r,\theta,\phi,\tau) \tag{3}$$

Consequently, the magnetic field components are related to the geomagnetic potential as follows:

$$B_r(r,\theta,\phi,\tau) = -\frac{\partial V(r,\theta,\phi,\tau)}{\partial r} \tag{4a}$$

$$B_\theta(r,\theta,\phi,\tau) = -\frac{1}{r}\frac{\partial V(r,\theta,\phi,\tau)}{\partial \theta} \tag{4b}$$

$$B_\phi(r,\theta,\phi,\tau) = -\frac{1}{r\sin\theta}\frac{\partial V(r,\theta,\phi,\tau)}{\partial \phi} \tag{4c}$$

which yield the following spherical harmonic expansions:

$$B_r(r,\theta,\phi,\tau) = \sum_{n=1}^{N}(n+1)\left(\frac{R_E}{r}\right)^{n+2}\sum_{m=0}^{n}\{g_{nm}(\tau)\cos m\phi + h_{nm}(\tau)\sin m\phi\}P_n^m(\theta) \tag{5a}$$

$$B_\theta(r,\theta,\phi,\tau) = -\sum_{n=1}^{N}\left(\frac{R_E}{r}\right)^{n+2}\sum_{m=0}^{n}\{g_{nm}(\tau)\cos m\phi + h_{nm}(\tau)\sin m\phi\}\frac{dP_n^m(\theta)}{d\theta} \tag{5b}$$

$$B_\phi(r,\theta,\phi,\tau) = \frac{1}{\sin\theta}\sum_{n=1}^{N}\left(\frac{R_E}{r}\right)^{n+2}\sum_{m=0}^{n}m\{g_{nm}(\tau)\sin m\phi - h_{nm}(\tau)\cos m\phi\}P_n^m(\theta) \tag{5c}$$

It must be noted that the Gauss coefficients $g_{nm}(\tau)$ and $h_{nm}(\tau)$, as well as the associated Legendre polynomials and their derivatives, are Schmidt normalized by an international agreement (circa 1930) of the International Union of Geodesy and Geophysics. This particular

normalization allows one to determine which terms of the spherical harmonic model are the most significant simply by a cursory inspection of the model coefficients. The Schmidt-normalized associated Legendre Polynomials $P_n^m(\theta)$ are related to the unnormalized associated Legendre Polynomials $P^{nm}(\theta)$ (note position of indices) by the following relation:

$$P_n^m(\theta) = S^{nm} P^{nm}(\theta) \tag{6}$$

The Schmidt normalization factors S^{nm} and the unnormalized associated Legendre Polynomials $P^{nm}(\theta)$ are computed via recurrence relationships as follows:

$$P^{00}(\theta) = 1 \tag{7a}$$

$$P^{nm}(\theta) = \sin\theta P^{n-1,m-1}(\theta) \qquad m = n \neq 0 \tag{7b}$$

$$P^{nm}(\theta) = \cos\theta P^{n-1,m} - K^{nm} P^{n-2,m} \qquad m \neq n, n \geq 1 \tag{7c}$$

$$\frac{dP^{00}(\theta)}{d\theta} = 0 \tag{7d}$$

$$\frac{dP^{nm}(\theta)}{d\theta} = \sin\theta \frac{dP^{n-1,m-1}(\theta)}{d\theta} + \cos\theta P^{n-1,m-1}(\theta) \qquad ,m = n \neq 0 \tag{7e}$$

$$\frac{dP^{nm}(\theta)}{d\theta} = \cos\theta \frac{dP^{n-1,m}}{d\theta} - \sin\theta P^{n-1,m}(\theta) - K^{nm} \frac{dP^{n-2,m}}{d\theta} \qquad ,m \neq n, n \geq 1 \tag{7f}$$

where:

$$K^{nm} = \frac{(n-1)^2 - m^2}{(2n-1)(2n-3)} \tag{8}$$

and where it is understood that the undefined polynomials $P^{-1,0}(\theta)$ and $\frac{dP^{-1,0}}{d\theta}(\theta)$ are to be set equal to zero. Similarly,

$$S^{00} = 1 \tag{9a}$$

$$S^{n0} = \left(\frac{2n-1}{n}\right) S^{n-1,0} \qquad ,n > 0 \tag{9b}$$

$$S^{nm} = \sqrt{\frac{(n-m+1)J}{n+m}}\; S^{n,m-1}, \qquad \begin{Bmatrix} J=2 & for & m=1 \\ J=1 & for & m>1 \end{Bmatrix} \tag{9c}$$

Also, computed via recursion relations are the longitudinally dependent functions $\cos(m\phi)$ and $\sin(m\phi)$, which are computed as follows:

$$\sin(m\phi) = 0 \qquad ,m=0 \tag{10a}$$

$$\cos(m\phi) = 1 \qquad ,m=0 \tag{10b}$$

$$\sin(m\phi) = \sin(\phi)\cos(m-1)\phi + \cos(\phi)\sin(m-1)\phi \qquad ,m>0 \tag{10c}$$

$$\cos(m\phi) = \cos(\phi)\cos(m-1)\phi - \sin(\phi)\sin(m-1)\phi \qquad ,m>0 \tag{10d}$$

1.2 Coordinate Transformations

GEOMAG is intended to compute various components of the geomagnetic field in a geodetic coordinate system that uses the WGS-84 ellipsoid as the reference ellipsoid. However, the mathematical analysis in the previous section is based on spherical coordinates. Consequently, some coordinate transformations are necessary. A three-step procedure is required.

a. Convert the geodetic latitude, longitude, and altitude (λ,ϕ,h) to spherical coordinates (r,θ,ϕ).

b. Compute the magnetic field components $B_r(r,\theta,\phi,\tau)$, $B_\theta(r,\theta,\phi,\tau)$, and $B_\phi(r,\theta,\phi,\tau)$.

c. Rotate the magnetic field components from spherical coordinates to geodetic coordinates yielding the magnetic field components $B_X(\lambda,\phi,h,\tau)$, $B_Y(\lambda,\phi,h,\tau)$, and $B_Z(\lambda,\phi,h,\tau)$, which are the projections of the magnetic field vector $\vec{B}(\lambda,\phi,h,\tau)$ onto the X-north, Y-east, and Z-vertically down coordinates of a local rectangular coordinate system defined by the tangent plane to the ellipsoid which is concentric about the WGS-84 reference ellipsoid but which encompasses the point (λ,ϕ,h).

The transformations in step a are as follows:

$$\cos\theta = \frac{\sin\lambda}{\sqrt{Q^2\cos^2\lambda + \sin^2\lambda}} \tag{11a}$$

$$\sin\theta = \sqrt{1-\cos^2\theta} \tag{11b}$$

where, if a and b are respectively the semi-major and semi-minor axes of the WGS-84 ellipsoid:

$$Q = \frac{h\sqrt{a^2-(a^2-b^2)\sin^2\lambda} + a^2}{h\sqrt{a^2-(a^2-b^2)\sin^2\lambda} + b^2} \tag{12}$$

Furthermore:

$$r^2 = h^2+2h\sqrt{a^2(a^2-b^2)\sin^2\lambda} + \frac{a^4-(a^4-b^4)\sin^2\lambda}{a^2-(a^2-b^2)\sin^2\lambda} \tag{13}$$

The transformation in step c depends on the rotation angle α through which the magnetic field vector must be rotated in going from spherical to geodetic coordinates. This rotation angle is defined by the following rotations:

$$\cos\alpha = \{h+\sqrt{a^2\cos^2\lambda+b^2\sin^2\lambda}\}/r \tag{14a}$$

$$\sin\alpha = (a^2-b^2)\cos\lambda\sin\lambda/\{r\sqrt{a^2\cos^2\lambda+b^2\sin^2\lambda}\} \tag{14b}$$

$$\alpha = \lambda-\frac{\pi}{2}+\theta \tag{14c}$$

Consequently, the components of the magnetic field vector in geodetic coordinates may be computed as follows:

$$B_X(\lambda,\phi,h,\tau) = -\cos\alpha B_\theta(r,\theta,\phi,\tau)-\sin\alpha B_r(r,\theta,\phi,\tau) \tag{15a}$$

$$B_Y(\lambda,\phi,h,\tau) = B_\phi(r,\theta,\phi,\tau) \tag{15b}$$

$$B_Z(\lambda,\phi,h,\tau) = \sin\alpha B_\theta(r,\theta,\phi,\tau)-\cos\alpha B_r(r,\theta,\phi,\tau) \tag{15c}$$

From these rectangular components of the geomagnetic field, it is possible to construct all others. In particular, the following parameters may be computed:

$$B_H(\lambda,\phi,h,\tau) = \sqrt{B_X^2(\lambda,\phi,h,\tau)+B_Y^2(\lambda,\phi,h,\tau)} \quad \text{(Horizontal Intensity)} \tag{16a}$$

$$B_F(\lambda,\phi,h,\tau) = \sqrt{B_H^2(\lambda,\phi,h,\tau)+B_Z^2(\lambda,\phi,h,\tau)} \quad \text{(Total Intensity)} \tag{16b}$$

$$B_D(\lambda,\phi,h,\tau) = \tan^{-1}\left\{\frac{B_Y(\lambda,\phi,h,\tau)}{B_X(\lambda,\phi,h,\tau)}\right\} \quad \text{(Declination)} \tag{16c}$$

$$B_I(\lambda,\phi,h,\tau) = \tan^{-1}\left\{\frac{B_Z(\lambda,\phi,h,\tau)}{B_H(\lambda,\phi,h,\tau)}\right\} \qquad \text{(Inclination)} \qquad (16d)$$

$$B_G(\lambda,\phi,h,\tau) = \begin{cases} B_D-\phi & \lambda\ge 0 \\ B_D+\phi & \lambda<0 \end{cases} \qquad \text{(Grid Variation)} \qquad (16e)$$

1.3 The Computer Algorithm

The Gauss coefficients at the base epoch, T_{EPOCH}, are stored in array C so that the lower half of array C is occupied by the even harmonic Gauss coefficients $g_{nm}(T_{EPOCH})$, while the upper half of array C is occupied by the odd harmonic Gauss coefficients $h_{nm}(T_{EPOCH})$. Table 1 illustrates the details of the storage scheme, which is equivalent to the following mathematical assignments:

$$C_{nm} = \begin{cases} g_{nm} & ,m\le n \\ h_{m,n+1} & ,m>n \end{cases} \qquad (17)$$

which implies that:

$$g_{nm} = C_{nm} \qquad ,m\le n \qquad (18a)$$

$$h_{nm} = C_{m-1,n} \qquad ,m\le n, m\ne 0 \qquad (18b)$$

The annual rates of change of the Gauss coefficients are stored in array CD (which stands for $\dot{C}$) so that the lower half of array CD is occupied by the even harmonic coefficients $\dot{g}_{nm}$, while the upper half of the array is occupied by the odd harmonic coefficients $\dot{h}_{nm}$. Table 2 illustrates the details of the storage scheme for array CD. It is essentially the same as table 1 for array C and corresponds to the following mathematical assignments:

$$\dot{C}_{nm} = \begin{cases} \dot{g}_{nm} & ,m\le n \\ \dot{h}_{m,n+1} & ,m>n \end{cases} \qquad (19)$$

which implies that:

$$\dot{g}_{nm} = \dot{C}_{nm} \qquad ,m\le n \qquad (20a)$$

$$\dot{h}_{nm} = \dot{C}_{m-1,n} \qquad ,m\le n, m\ne 0 \qquad (20b)$$

TABLE 1. ARRANGEMENT OF MAIN FIELD COEFFICIENTS IN ARRAY C_{nm}

n\m	0	1	2	3	4	5	6	7	8	9	10	11	12
0	g_{00}	h_{11}	h_{21}	h_{31}	h_{41}	h_{51}	h_{61}	h_{71}	h_{81}	h_{91}	$h_{10,1}$	$h_{11,1}$	$h_{12,1}$
1	g_{10}	g_{11}	h_{22}	h_{32}	h_{42}	h_{52}	h_{62}	h_{72}	h_{82}	h_{92}	$h_{10,2}$	$h_{11,2}$	$h_{12,2}$
2	g_{20}	g_{21}	g_{22}	h_{33}	h_{43}	h_{53}	h_{63}	h_{73}	h_{83}	h_{93}	$h_{10,3}$	$h_{11,3}$	$h_{12,3}$
3	g_{30}	g_{31}	g_{32}	g_{33}	h_{44}	h_{54}	h_{64}	h_{74}	h_{84}	h_{94}	$h_{10,4}$	$h_{11,4}$	$h_{12,4}$
4	g_{40}	g_{41}	g_{42}	g_{43}	g_{44}	h_{55}	h_{65}	h_{75}	h_{85}	h_{95}	$h_{10,5}$	$h_{11,5}$	$h_{12,5}$
5	g_{50}	g_{51}	g_{52}	g_{53}	g_{54}	g_{55}	h_{66}	h_{76}	h_{86}	h_{96}	$h_{10,6}$	$h_{11,6}$	$h_{12,6}$
6	g_{60}	g_{61}	g_{62}	g_{63}	g_{64}	g_{65}	g_{66}	h_{77}	h_{87}	h_{97}	$h_{10,7}$	$h_{11,7}$	$h_{12,7}$
7	g_{70}	g_{71}	g_{72}	g_{73}	g_{74}	g_{75}	g_{76}	g_{77}	h_{88}	h_{98}	$h_{10,8}$	$h_{11,8}$	$h_{12,8}$
8	g_{80}	g_{81}	g_{82}	g_{83}	g_{84}	g_{85}	g_{86}	g_{87}	g_{88}	h_{99}	$h_{10,9}$	$h_{11,9}$	$h_{12,9}$
9	g_{90}	g_{91}	g_{92}	g_{93}	g_{94}	g_{95}	g_{96}	g_{97}	g_{98}	g_{99}	$h_{10,10}$	$h_{11,10}$	$h_{12,10}$
10	$g_{10,0}$	$g_{10,1}$	$g_{10,2}$	$g_{10,3}$	$g_{10,4}$	$g_{10,5}$	$g_{10,6}$	$g_{10,7}$	$g_{10,8}$	$g_{10,9}$	$g_{10,10}$	$h_{11,11}$	$h_{12,11}$
11	$g_{11,0}$	$g_{11,1}$	$g_{11,2}$	$g_{11,3}$	$g_{11,4}$	$g_{11,5}$	$g_{11,6}$	$g_{11,7}$	$g_{11,8}$	$g_{11,9}$	$g_{11,10}$	$g_{11,11}$	$h_{12,12}$
12	$g_{12,0}$	$g_{12,1}$	$g_{12,2}$	$g_{12,3}$	$g_{12,4}$	$g_{12,5}$	$g_{12,6}$	$g_{12,7}$	$g_{12,8}$	$g_{12,9}$	$g_{12,10}$	$g_{12,11}$	$g_{12,12}$

TABLE 2. ARRANGEMENT OF SECULAR VARIATION COEFFICIENTS IN ARRAY $\dot{C}_{nm}$

n\m	0	1	2	3	4	5	6	7	8	9	10	11	12
0	$\dot{g}_{00}$	$\dot{h}_{11}$	$\dot{h}_{21}$	$\dot{h}_{31}$	$\dot{h}_{41}$	$\dot{h}_{51}$	$\dot{h}_{61}$	$\dot{h}_{71}$	$\dot{h}_{81}$	$\dot{h}_{91}$	$\dot{h}_{10,1}$	$\dot{h}_{11,1}$	$\dot{h}_{12,1}$
1	$\dot{g}_{10}$	$\dot{g}_{11}$	$\dot{h}_{22}$	$\dot{h}_{32}$	$\dot{h}_{42}$	$\dot{h}_{52}$	$\dot{h}_{62}$	$\dot{h}_{72}$	$\dot{h}_{82}$	$\dot{h}_{92}$	$\dot{h}_{10,2}$	$\dot{h}_{11,2}$	$\dot{h}_{12,2}$
2	$\dot{g}_{20}$	$\dot{g}_{21}$	$\dot{g}_{22}$	$\dot{h}_{33}$	$\dot{h}_{43}$	$\dot{h}_{53}$	$\dot{h}_{63}$	$\dot{h}_{73}$	$\dot{h}_{83}$	$\dot{h}_{93}$	$\dot{h}_{10,3}$	$\dot{h}_{11,3}$	$\dot{h}_{12,3}$
3	$\dot{g}_{30}$	$\dot{g}_{31}$	$\dot{g}_{32}$	$\dot{g}_{33}$	$\dot{h}_{44}$	$\dot{h}_{54}$	$\dot{h}_{64}$	$\dot{h}_{74}$	$\dot{h}_{84}$	$\dot{h}_{94}$	$\dot{h}_{10,4}$	$\dot{h}_{11,4}$	$\dot{h}_{12,4}$
4	$\dot{g}_{40}$	$\dot{g}_{41}$	$\dot{g}_{42}$	$\dot{g}_{43}$	$\dot{g}_{44}$	$\dot{h}_{55}$	$\dot{h}_{65}$	$\dot{h}_{75}$	$\dot{h}_{85}$	$\dot{h}_{95}$	$\dot{h}_{10,5}$	$\dot{h}_{11,5}$	$\dot{h}_{12,5}$
5	$\dot{g}_{50}$	$\dot{g}_{51}$	$\dot{g}_{52}$	$\dot{g}_{53}$	$\dot{g}_{54}$	$\dot{g}_{55}$	$\dot{h}_{66}$	$\dot{h}_{76}$	$\dot{h}_{86}$	$\dot{h}_{96}$	$\dot{h}_{10,6}$	$\dot{h}_{11,6}$	$\dot{h}_{12,6}$
6	$\dot{g}_{60}$	$\dot{g}_{61}$	$\dot{g}_{62}$	$\dot{g}_{63}$	$\dot{g}_{64}$	$\dot{g}_{65}$	$\dot{g}_{66}$	$\dot{h}_{77}$	$\dot{h}_{87}$	$\dot{h}_{97}$	$\dot{h}_{10,7}$	$\dot{h}_{11,7}$	$\dot{h}_{12,7}$
7	$\dot{g}_{70}$	$\dot{g}_{71}$	$\dot{g}_{72}$	$\dot{g}_{73}$	$\dot{g}_{74}$	$\dot{g}_{75}$	$\dot{g}_{76}$	$\dot{g}_{77}$	$\dot{h}_{88}$	$\dot{h}_{98}$	$\dot{h}_{10,8}$	$\dot{h}_{11,8}$	$\dot{h}_{12,8}$
8	$\dot{g}_{80}$	$\dot{g}_{81}$	$\dot{g}_{82}$	$\dot{g}_{83}$	$\dot{g}_{84}$	$\dot{g}_{85}$	$\dot{g}_{86}$	$\dot{g}_{87}$	$\dot{g}_{88}$	$\dot{h}_{99}$	$\dot{h}_{10,9}$	$\dot{h}_{11,9}$	$\dot{h}_{12,9}$
9	$\dot{g}_{90}$	$\dot{g}_{91}$	$\dot{g}_{92}$	$\dot{g}_{93}$	$\dot{g}_{94}$	$\dot{g}_{95}$	$\dot{g}_{96}$	$\dot{g}_{97}$	$\dot{g}_{98}$	$\dot{g}_{99}$	$\dot{h}_{10,10}$	$\dot{h}_{11,10}$	$\dot{h}_{12,10}$
10	$\dot{g}_{10,0}$	$\dot{g}_{10,1}$	$\dot{g}_{10,2}$	$\dot{g}_{10,3}$	$\dot{g}_{10,4}$	$\dot{g}_{10,5}$	$\dot{g}_{10,6}$	$\dot{g}_{10,7}$	$\dot{g}_{10,8}$	$\dot{g}_{10,9}$	$\dot{g}_{10,10}$	$\dot{h}_{11,11}$	$\dot{h}_{12,11}$
11	$\dot{g}_{11,0}$	$\dot{g}_{11,1}$	$\dot{g}_{11,2}$	$\dot{g}_{11,3}$	$\dot{g}_{11,4}$	$\dot{g}_{11,5}$	$\dot{g}_{11,6}$	$\dot{g}_{11,7}$	$\dot{g}_{11,8}$	$\dot{g}_{11,9}$	$\dot{g}_{11,10}$	$\dot{g}_{11,11}$	$\dot{h}_{12,12}$
12	$\dot{g}_{12,0}$	$\dot{g}_{12,1}$	$\dot{g}_{12,2}$	$\dot{g}_{12,3}$	$\dot{g}_{12,4}$	$\dot{g}_{12,5}$	$\dot{g}_{12,6}$	$\dot{g}_{12,7}$	$\dot{g}_{12,8}$	$\dot{g}_{12,9}$	$\dot{g}_{12,10}$	$\dot{g}_{12,11}$	$\dot{g}_{12,12}$

The numerical values of the Gauss coefficients at the base epoch and their corresponding annual rates of change for the WMM-90 geomagnetic model are listed in table 3. These numerical values are inserted into arrays C and CD through data statements. The base epoch of the model is also assigned through a data statement. In order to update the GEOMAG algorithm to a new epoch geomagnetic model such as WMM-95, it is necessary to replace only the data statements with the new model coefficients and the new base epoch.

Important parameters in the GEOMAG routine and their mathematical correspondences are:

$$A \sim a \;=\; 6378.137 \;\; km$$
$$B \sim b \;=\; 6356.7523142 \;\; km$$
$$RE \sim R_E \;=\; 6371.2 \;\; km$$
$$TIME \sim \tau$$
$$EPOCH \sim T_{EPOCH}$$
$$DT \sim \tau - T_{EPOCH}$$
$$ALT \sim h$$
$$SNORM(N,M) \sim S^{nm}$$
$$K(N,M) \sim \kappa^{nm}$$
$$GLAT \sim \lambda$$
$$GLON \sim \phi$$
$$SP(M) \sim \sin(m\phi)$$
$$CP(M) \sim \cos(m\phi)$$
$$ST \sim \sin(\theta)$$
$$CT \sim \cos(\theta)$$
$$CA \sim \cos(\alpha)$$
$$SA \sim \sin(\alpha)$$
$$BR \sim B_r$$
$$BT \sim B_\theta$$
$$BP \sim B_\phi$$
$$BX \sim B_X$$
$$BY \sim B_Y$$
$$BZ \sim B_Z$$
$$BH \sim B_H$$
$$DEC \sim B_D$$
$$DIP \sim B_I$$
$$TI \sim B_{TI}$$
$$MAXDEG \sim N$$
$$MAXORD \sim M = N$$
$$P(N,M) \sim P^{nm}$$
$$DP(N,M) \sim \frac{dP^{nm}}{d\theta}$$

$$
\begin{aligned}
TC &\sim C+(\tau-T_{EPOCH})\dot{C}\\
CD &\sim \dot{C}\\
Q2 &\sim Q^2
\end{aligned}
$$

Note that R_E is *not* intended to be the mean radius of the WGS-84 ellipsoid. It is the mean radius of a modified IAU-66 ellipsoid.

The GEOMAG algorithm is organized into two modules, each with its own entry point. The first is an Initialization Module. Its purpose is to compute all constants such as the recursion relation factors for the associated Legendre polynomials K^{nm}, the Schmidt normalization factors S^{nm}, and any other parameters that do not depend on position or time. The entry point for this module is GEOMAG (MAXDEG). The parameter *MAXDEG determines the maximum degree and order of the* magnetic model to be used in the computations. Normally, MAXDEG = 12, which is the maximum degree and order of the WMM series geomagnetic models. In order to reduce computation time, MAXDEG may be set to a number less than 12 (e.g., 8 or 10). However, the accuracy of the computed magnetic parameters is correspondingly reduced. MAXDEG must be set in the calling program. The second module is the Processing Module, which has the entry point

GEOMG1 (ALT, GLAT, GLON, TIME, DEC, DIP, TI, GV).

The purpose of this module is to compute the magnetic declination, inclination, total intensity, and grid variation of each geodetic position and time supplied to it. The units of the parameters in the argument list of the GEOMG1 entry point are as follows:

ALT ~ kilometers (e.g., 5.314)	(In)
GLAT ~ degrees (e.g., 33.716)	(In)
GLON ~ degrees (e.g., -163.315)	(In)
TIME ~ years (e.g., 1992.427)	(In)
DEC ~ degrees (e.g., -121.734)	(Out)
DIP ~ degrees (e.g., 48.387)	(Out)
TI ~ nanoteslas (e.g., 35781.7)	(Out)
GV ~ degrees (e.g., 51.768)	(Out)

The computed magnetic field parameters are referenced to the WGS-84 ellipsoid. The last parameter, GV, is the grid variation which is computed *only in the polar regions (i.e., above* + 55° latitude or below - 55° latitude). Outside of this region, a value of -999.0 is dummied in. It is referenced to grid north of a polar stereographic projection. The model is considered valid at altitudes ranging from sea level to 1000 km.

TABLE 3. WMM-90 SCHMIDT NORMALIZED GAUSS COEFFICIENTS (nT)

n	m	g_{nm}	h_{nm}	$\dot{g}_{nm}$	$\dot{h}_{nm}$
1	0	-29780.5	.0	16.0	.0
1	1	-1851.7	5407.2	9.3	-13.8
2	0	-2134.3	.0	-11.7	.0
2	1	3062.2	-2278.3	3.7	-12.8
2	2	1691.9	-384.3	1.8	-14.9
3	0	1312.9	.0	2.1	.0
3	1	-2244.7	-284.9	-7.6	3.1
3	2	1246.8	291.7	.0	.8
3	3	808.6	-352.4	-5.8	-11.3
4	0	933.5	.0	-.8	.0
4	1	784.9	249.4	1.0	3.3
4	2	323.5	-232.7	-7.4	3.7
4	3	-421.7	91.3	.8	2.8
4	4	139.2	-296.5	-6.4	.0
5	0	-208.3	.0	1.7	.0
5	1	352.2	40.8	.0	.0
5	2	246.5	148.7	.0	-2.1
5	3	-110.8	-154.6	-2.7	1.2
5	4	-162.3	-67.6	.0	1.2
5	5	-37.2	97.4	3.0	.6
6	0	59.0	.0	.8	.0
6	1	63.7	-14.7	.0	-.6
6	2	60.0	82.2	1.5	-.6
6	3	-181.3	70.0	.0	.0
6	4	.4	-56.2	.0	-2.3
6	5	15.4	-1.4	.0	.0
6	6	-96.0	24.6	.0	.0
7	0	76.1	.0	.5	.0
7	1	-62.1	-78.6	.0	.6
7	2	1.3	-26.7	-.9	.8
7	3	30.2	.1	1.5	.0
7	4	4.7	19.9	2.7	.0
7	5	7.9	17.9	-1.0	.0
7	6	10.1	-21.5	.0	.4
7	7	1.9	-6.8	.0	.0
8	0	22.9	.0	.0	.0
8	1	2.3	9.7	-1.1	.4
8	2	-1.2	-19.3	.0	-.8
8	3	-11.7	6.6	.0	.5
8	4	-17.5	-20.1	-2.1	.3
8	5	2.2	13.4	.0	.5
8	6	5.7	9.8	1.0	.0
8	7	3.0	-19.0	.0	-.7
8	8	-7.0	-9.1	.0	.0

TABLE 3. WMM-90 SCHMIDT NORMALIZED GAUSS COEFFICIENTS (con.)

n	m	g_{nm}	h_{nm}	$\dot{g}_{nm}$	$\dot{h}_{nm}$
9	0	3.6	.0	.0	.0
9	1	9.5	-21.9	.0	.0
9	2	-.9	14.3	.0	.0
9	3	-10.7	9.5	.0	.0
9	4	10.7	-6.7	.0	.0
9	5	-3.2	-6.4	.0	.0
9	6	-1.4	9.1	.0	.0
9	7	6.3	8.9	.0	.0
9	8	.8	-8.0	.0	.0
9	9	-5.5	2.1	.0	.0
10	0	-3.3	.0	.0	.0
10	1	-2.6	2.6	.0	.0
10	2	4.5	1.2	.0	.0
10	3	-5.6	2.6	.0	.0
10	4	-3.6	5.7	.0	.0
10	5	3.9	-4.0	.0	.0
10	6	3.2	-.4	.0	.0
10	7	1.7	-1.7	.0	.0
10	8	3.0	3.8	.0	.0
10	9	3.7	-.8	.0	.0
10	10	.7	-6.5	.0	.0
11	0	1.3	.0	.0	.0
11	1	-1.4	.0	.0	.0
11	2	-2.5	1.0	.0	.0
11	3	3.2	-1.6	.0	.0
11	4	.2	-2.2	.0	.0
11	5	-1.1	1.1	.0	.0
11	6	.3	-.7	.0	.0
11	7	-.3	-1.7	.0	.0
11	8	.9	-1.5	.0	.0
11	9	-1.1	-1.3	.0	.0
11	10	2.4	-1.1	.0	.0
11	11	3.0	.6	.0	.0
12	0	-1.3	.0	.0	.0
12	1	.1	.7	.0	.0
12	2	.5	.7	.0	.0
12	3	.7	1.3	.0	.0
12	4	.4	-1.5	.0	.0
12	5	-.2	.3	.0	.0
12	6	-1.1	.2	.0	.0
12	7	.9	-1.1	.0	.0
12	8	-.6	1.2	.0	.0
12	9	.8	-.2	.0	.0
12	10	.2	-1.3	.0	.0
12	11	.4	.6	.0	.0
12	12	.2	.6	.0	.0

SECTION 2. THE 1990 EPOCH WORLD MAGNETIC MODEL (DERIVATION)

2.0 Overview

There were four major data sets available for the 1990 model. These were: the MAGSAT satellite data collected during 1979 and 1980; the DE-2 satellite data collected from 1981 through 1983; Project MAGNET aeromagnetic data collected between 1980 and 1990; and geomagnetic observatory annual magnetic means data collected between 1980 and 1990. The global distribution of these data is illustrated in charts 1 through 4.

Four factors which affect the quality of the model produced and which influence the overall approach taken to produce the model are:

a. The age of the data relative to the model epoch;
b. The temporal coherence of the data;
c. The spatial uniformity of the data; and
d. The data density.

With respect to these factors, none of the four data sets are ideal. All four data sets, especially the satellite data sets, are dominated by older data. The Project MAGNET data, in addition, are neither temporally coherent nor spatially uniform. Furthermore, the observatory annual means data are sparse and suffer from severe spatial nonuniformity.

The modeling objective is to create two spherical harmonic models. One model characterizes the Earth's *main* (core-generated) magnetic field at the 1990.0 epoch. The other model characterizes the Earth's secular (slow temporal) magnetic variations of Earth core origin for five years beyond the 1990 epoch.

Given the objective and the available data, the following procedure was adopted:

a. Use the observatory annual magnetic means to create two definitive secular variation models, the first covering the 5-year interval 1980 to 1985, and the second covering the 5-year interval 1985 to 1990. These are referred to as the 1982.5 and 1987.5 definitive secular variation models, respectively.

b. Use the observatory annual magnetic means to create, by extrapolation, one predictive secular variation model covering the 5-year interval 1990 to 1995. It is referred to as the 1992.5 predictive secular variation model.

c. Use the two definitive secular variation models to push the satellite and aircraft magnetic field observations forward or backward, as appropriate, to 1985.0.

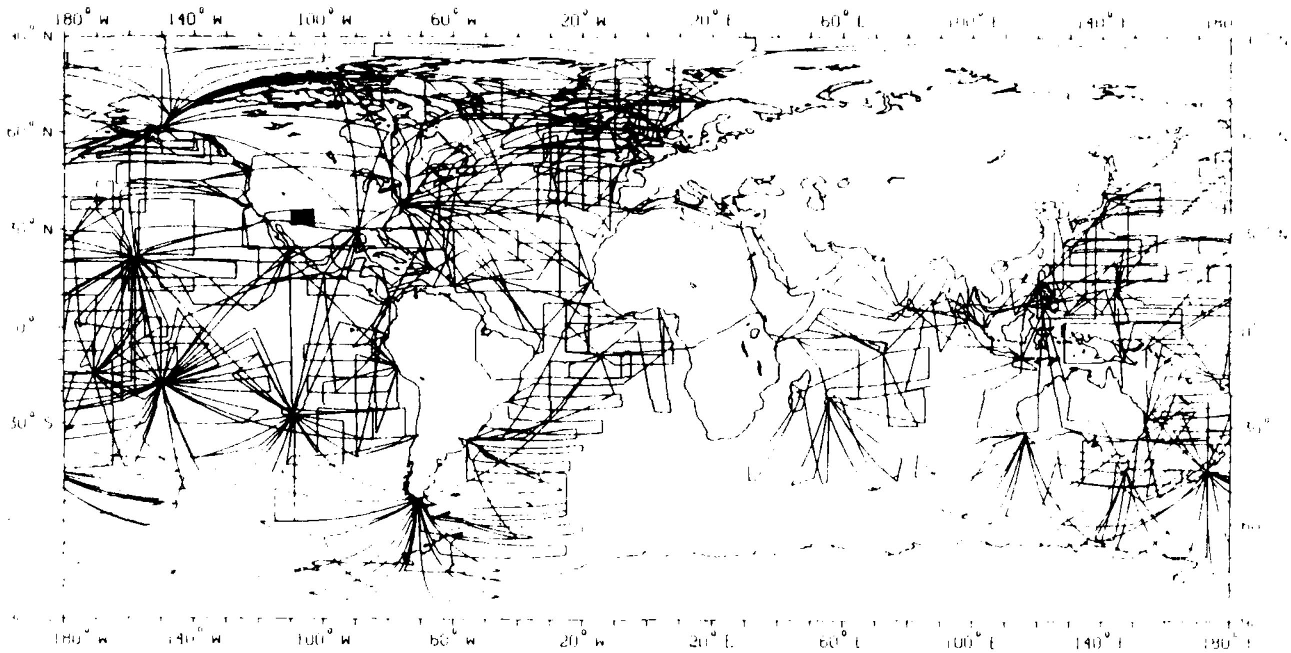


CHART 1. PROJECT MAGNET DATA DISTRIBUTION (FROM SURVEYS PERFORMED DURING THE PERIOD 1980-1989)

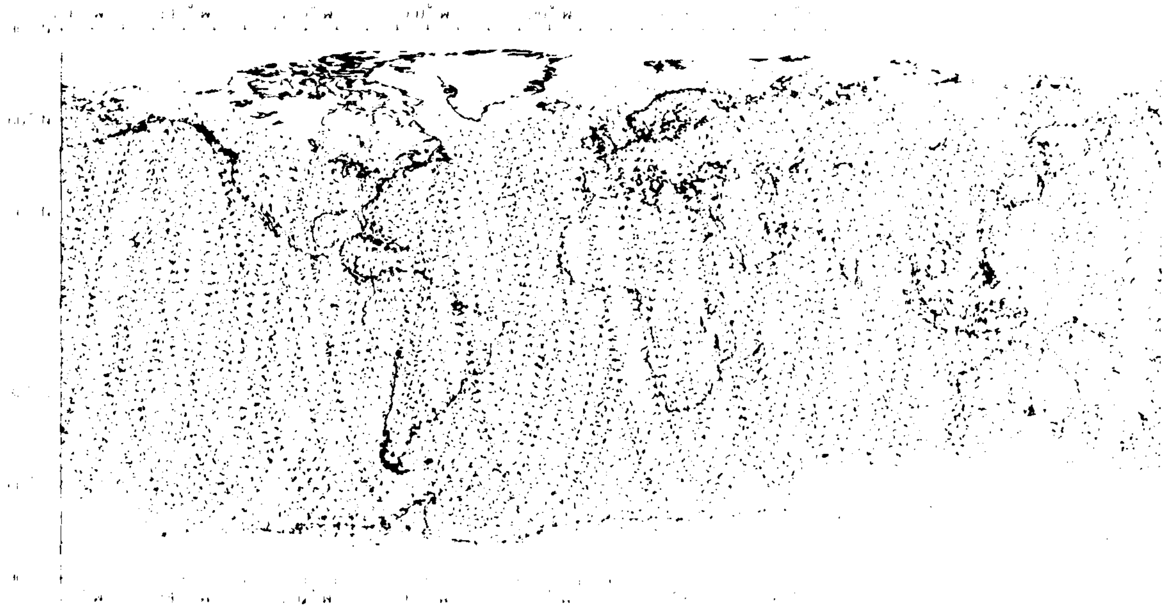


CHART 2. MAGSAT DATA DISTRIBUTION

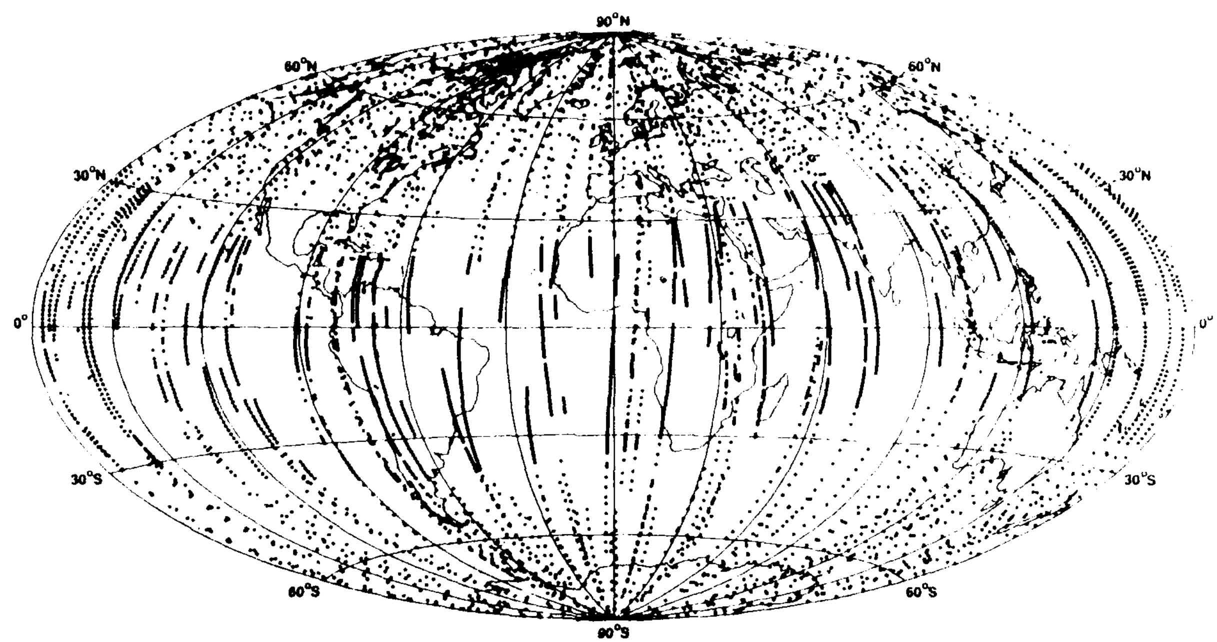
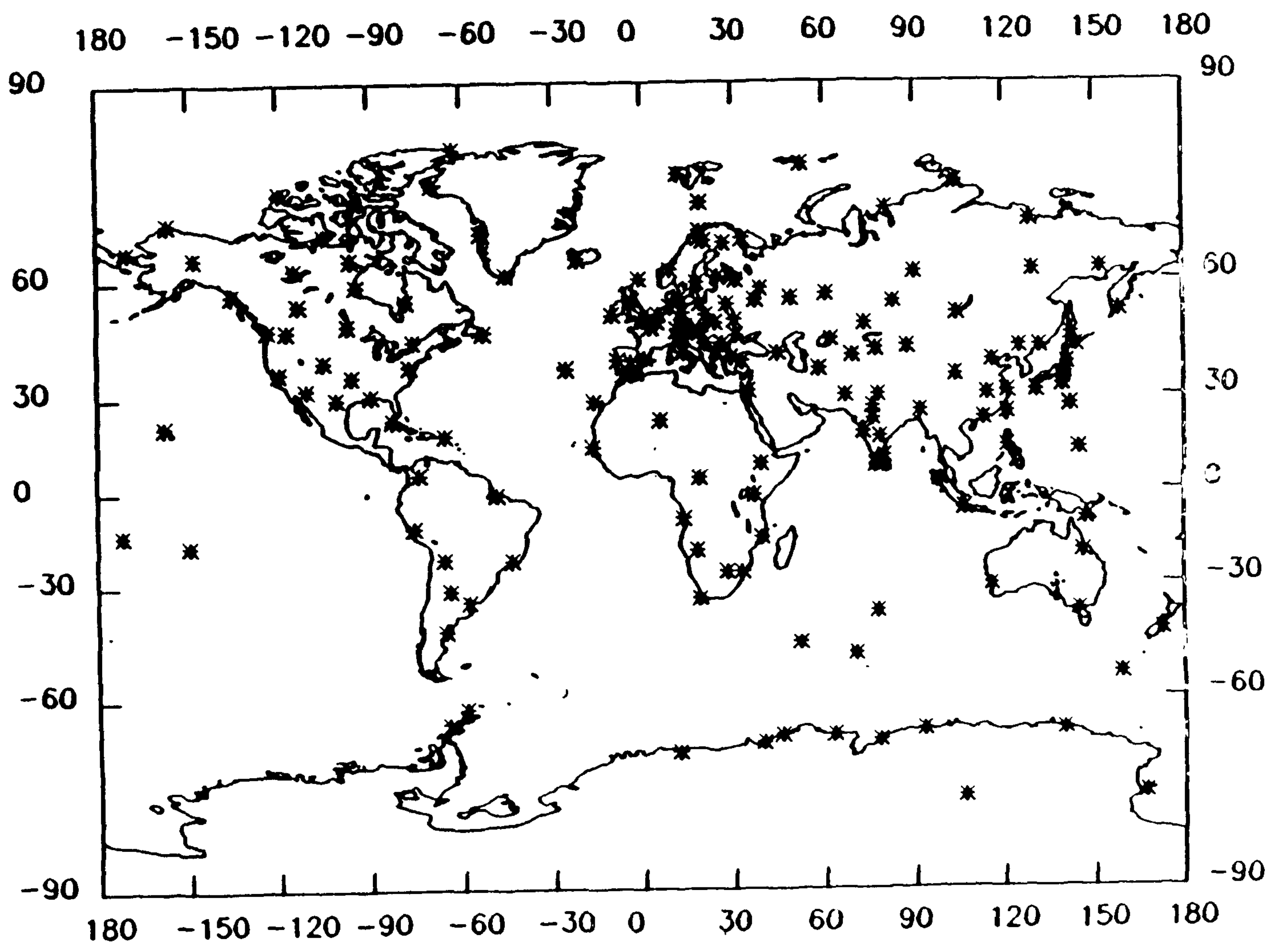


CHART 3. DE-2 DATA DISTRIBUTION



(Courtesy British Geological Survey)

CHART 4. GEOMAGNETIC OBSERVATORY DISTRIBUTION

d. Create a 1985.0 epoch main field model using the time-adjusted satellite and aircraft magnetic field observations via a weighted least-square inversion.

e. Use the 1987.5 definitive secular variation model to push the spherical harmonic coefficients of the 1985.0 epoch main field model forward to the 1990.0 epoch, thereby yielding the 1990.0 epoch main field model.

f. Combine the 1990 epoch main field model coefficients with the 1992.5 predictive secular variation model coefficients to form the 1990 World Magnetic Model, WMM-90.

A by-product of this procedure is a revised 1985.0 epoch World Chart Model which is obtained by combining the 1985.0 main field coefficients generated in step d with the 1987.5 definitive secular variation model coefficients generated in step a.

2.1 Secular Variation Data Analysis (British Responsibility)

The only data available for secular variation modeling are the observatory magnetic annual means, the first time derivative which provides information concerning the slow (greater than one year) rates of change of various components of the Earth's main magnetic field at various geographic locations (roughly 200) around the world. Because of the sparsity and spatial nonuniformity of this data, it is possible to generate only a degree and order 8 spherical harmonic model of the secular variation. Furthermore, the predictive model is necessarily based on extrapolations of each magnetic component at each observatory site. Examples of observatory annual means from a few selected sites such as Honolulu, Huancayo, Pilar, and Rude Skov, for the X-north, Y-east, and Z-vertically down components of the Earth's magnetic field, are given in figures (1a), (1b), (1c), (1d), (1e) and (1f) through (4a), (4b), (4c), (4d), (4e) and (4f). The discontinuities in the field components at Honolulu are due to repositioning of the observatory at two separate instances. In several instances, the rate of change of one or more field components at an observatory has reversed direction over time intervals as short as two or three years. The sudden, unpredictable nature of the Earth's field is well illustrated by these observatories. The first-order time derivative of these data contains magnetic field contributions from the Earth's core as well as from the ionosphere and magnetosphere. It is difficult to remove the external field effects from these data because much of it is related to the solar cycle and many observatories do not have a sufficiently long history for a detailed analysis. Consequently, some external field effects are not removed from these data at the expense of a somewhat larger uncertainty in the secular variation model coefficients.

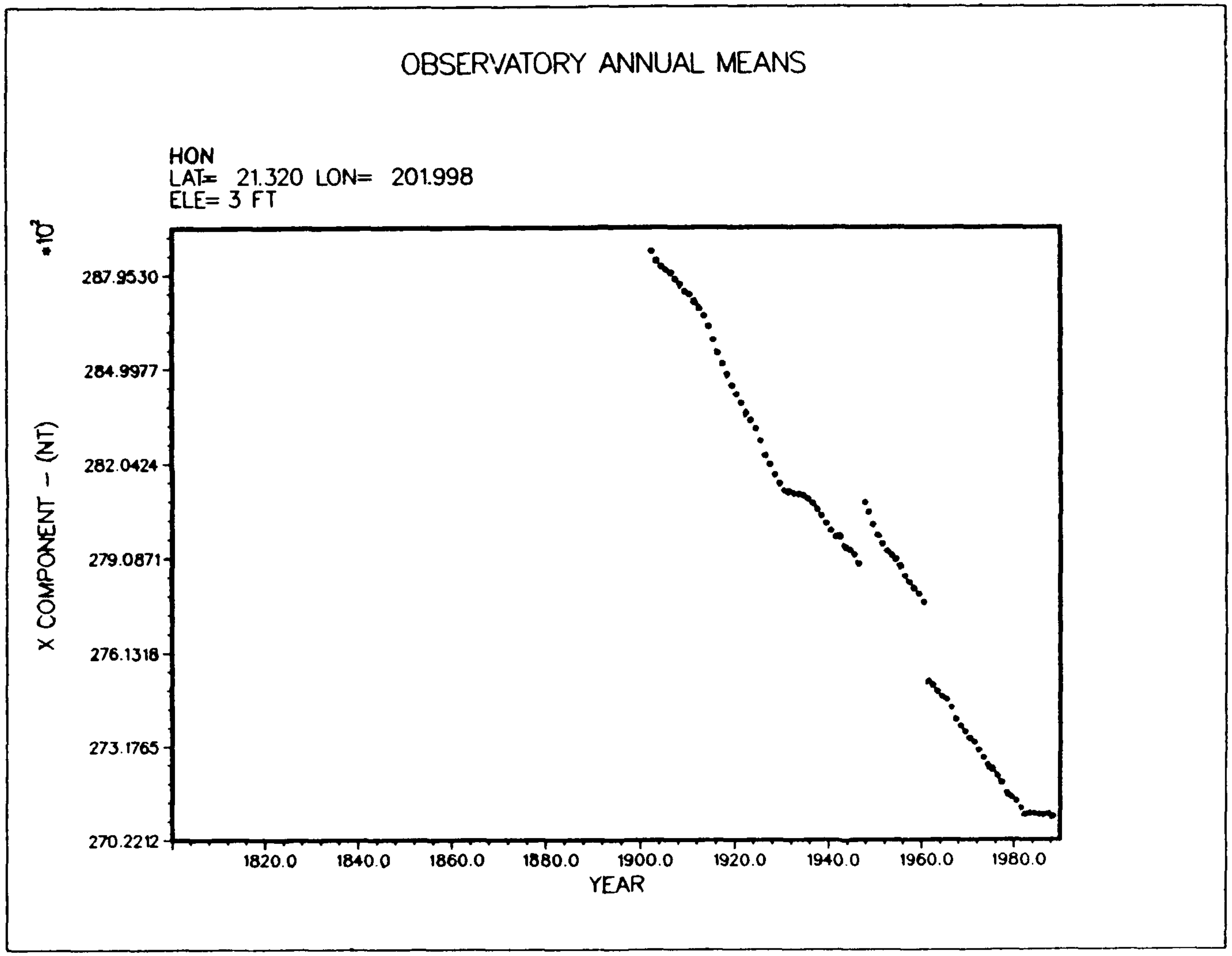


FIGURE 1a. NORTH X COMPONENT AT HONOLULU (HON).

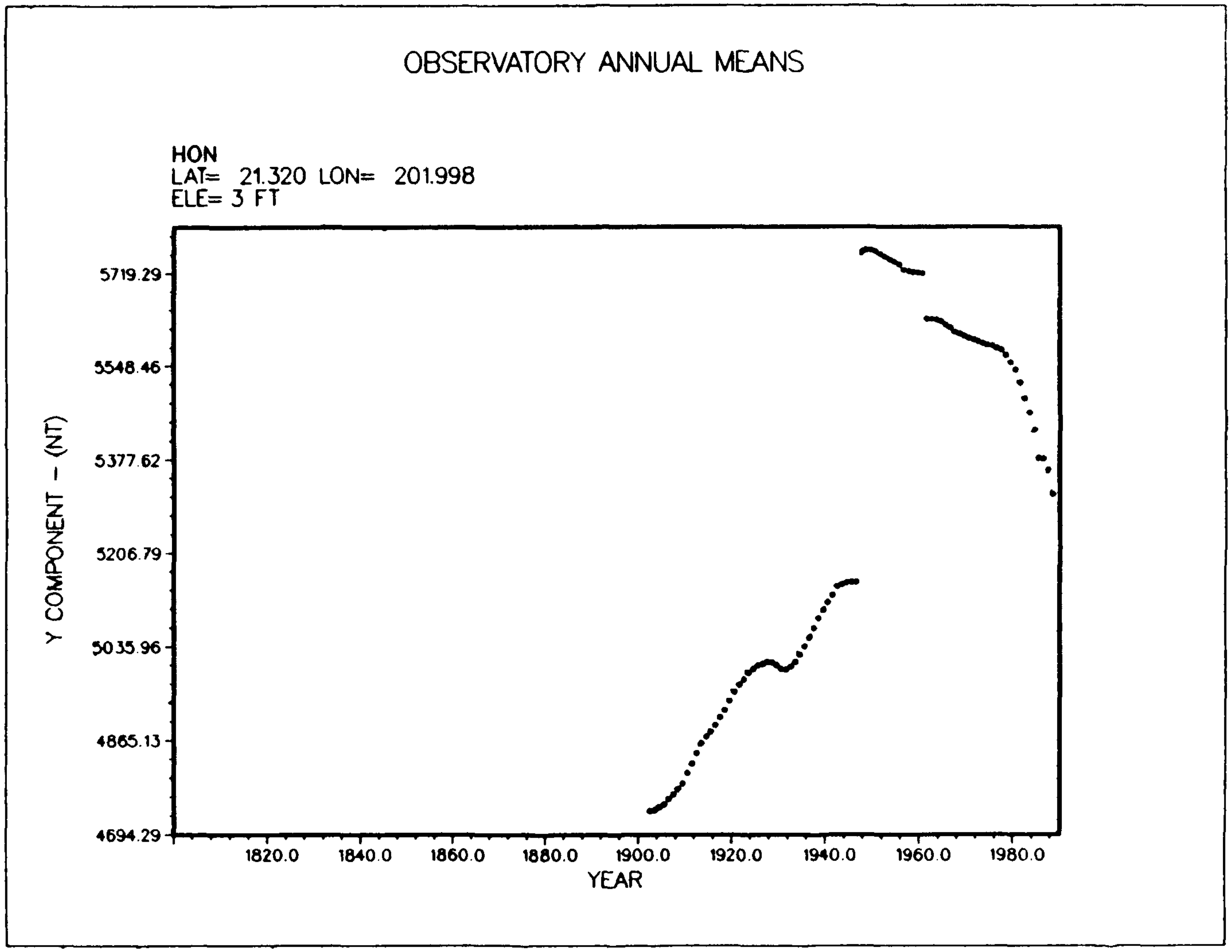


FIGURE 1b. EAST Y COMPONENT AT HONOLULU (HON).

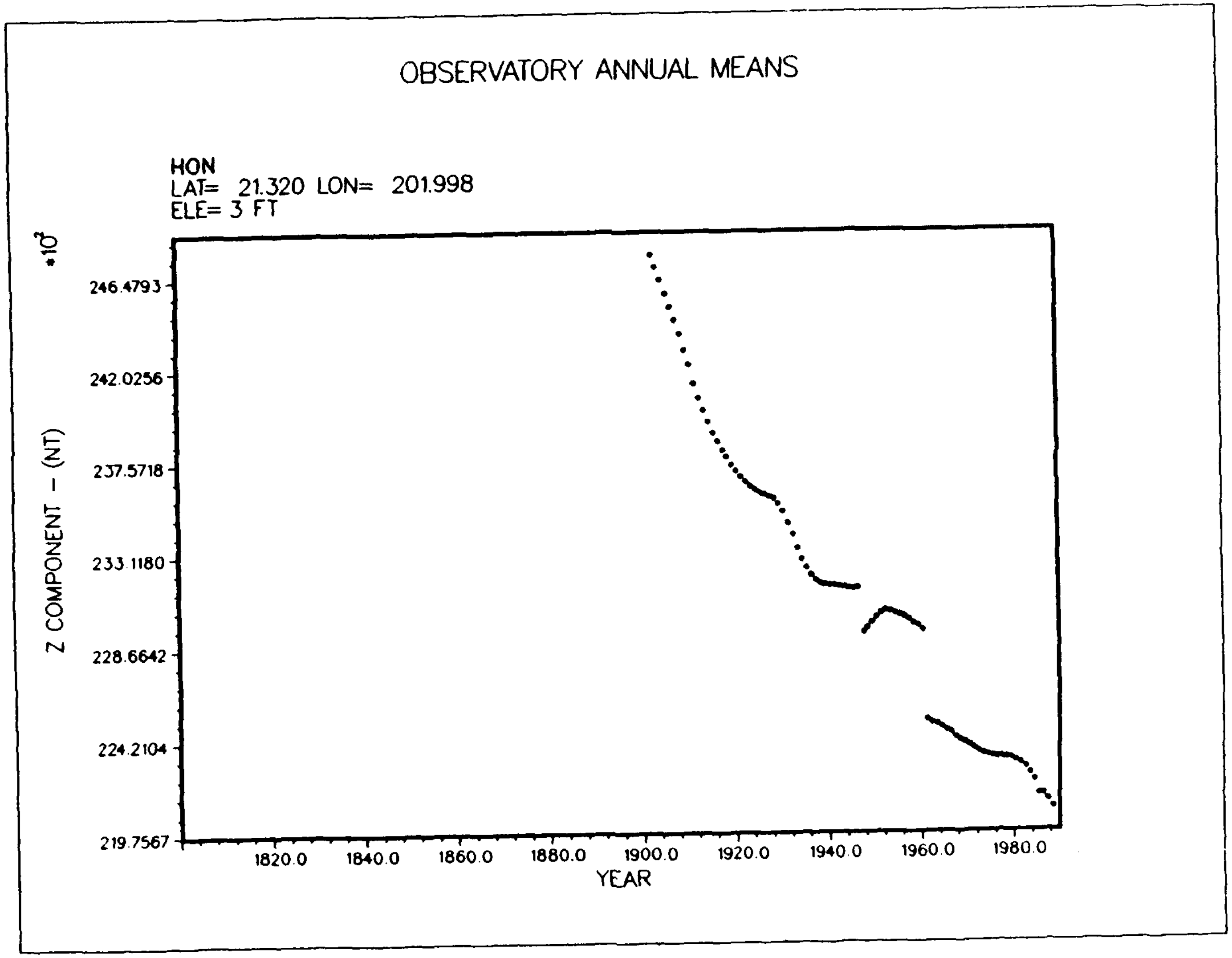


FIGURE 1c. VERTICAL Z COMPONENT AT HONOLULU (HON).

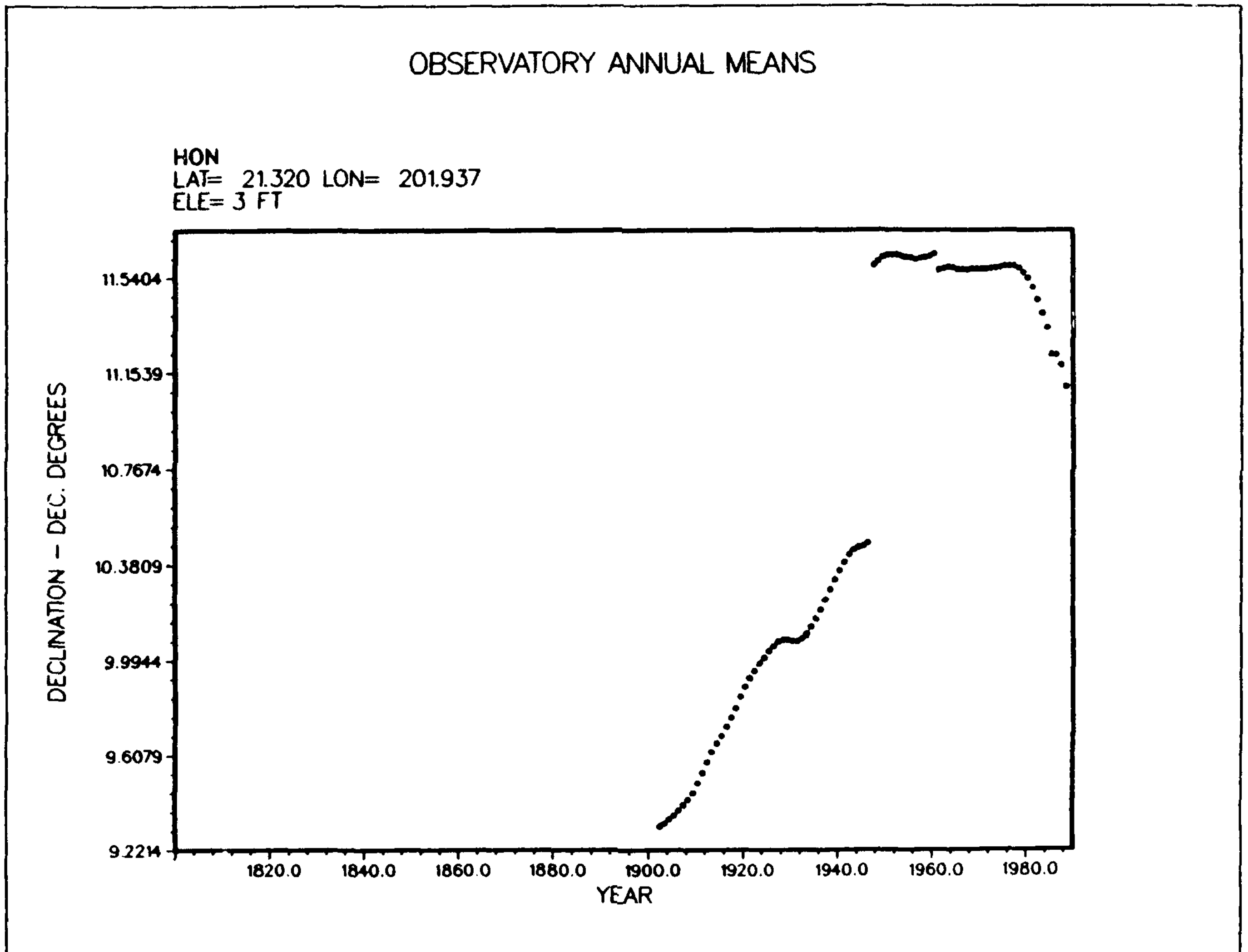


FIGURE 1d. DECLINATION D COMPONENT AT HONOLULU (HON).

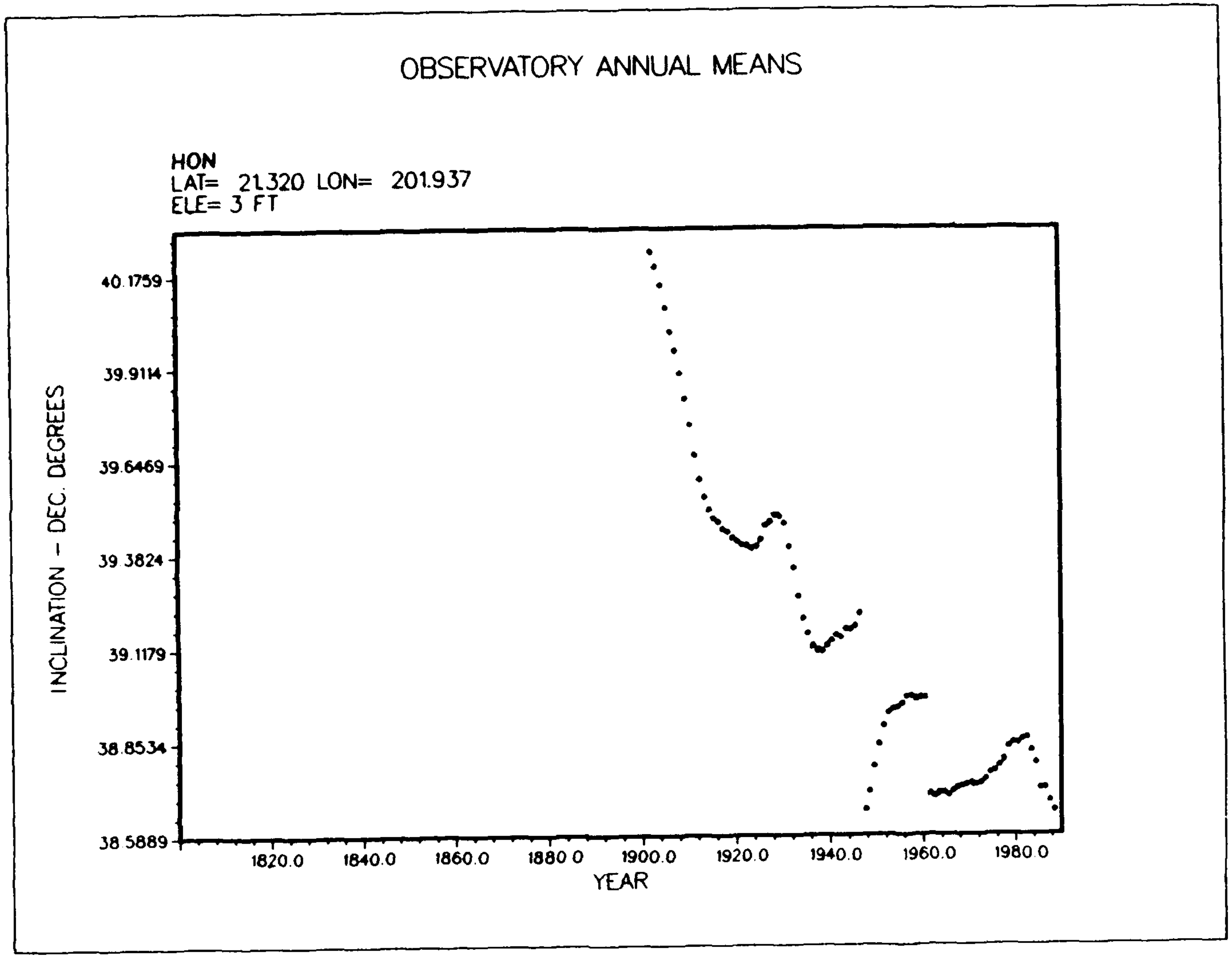


FIGURE 1e. INCLINATION I COMPONENT AT HONOLULU (HON).

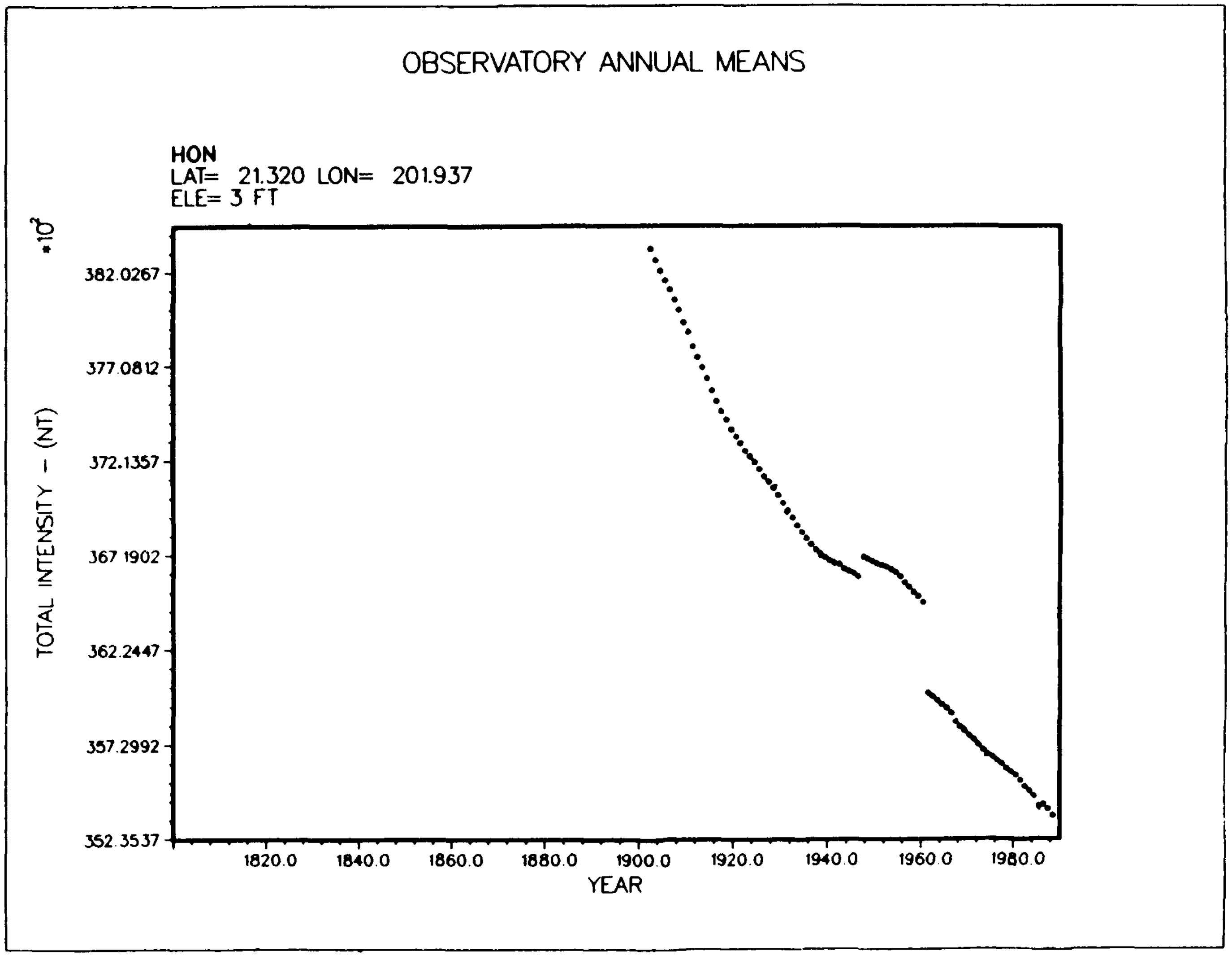


FIGURE 1f. TOTAL INTENSITY F COMPONENT AT HONOLULU (HON).

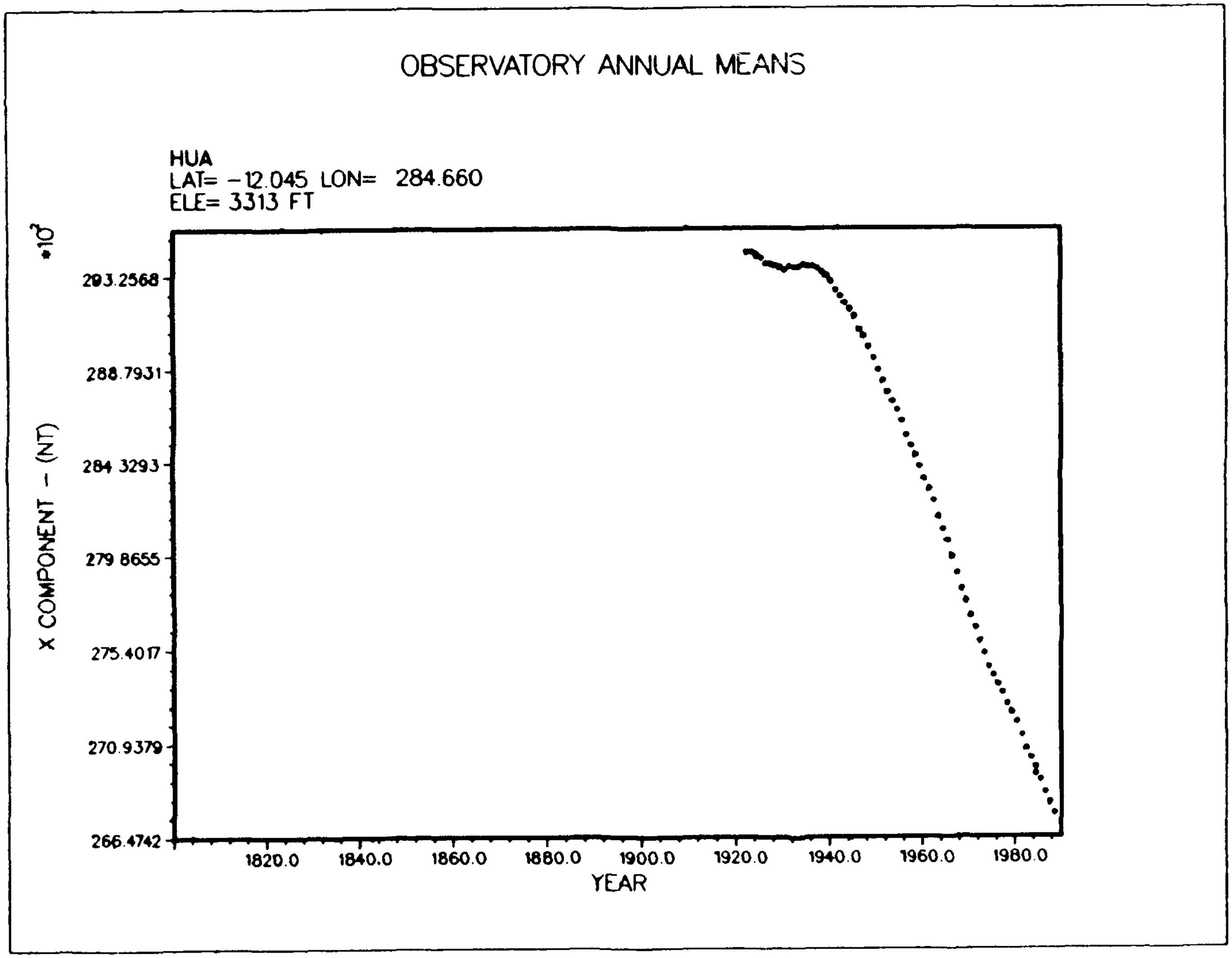


FIGURE 2a. NORTH X COMPONENT AT HUANCAYO (HUA).

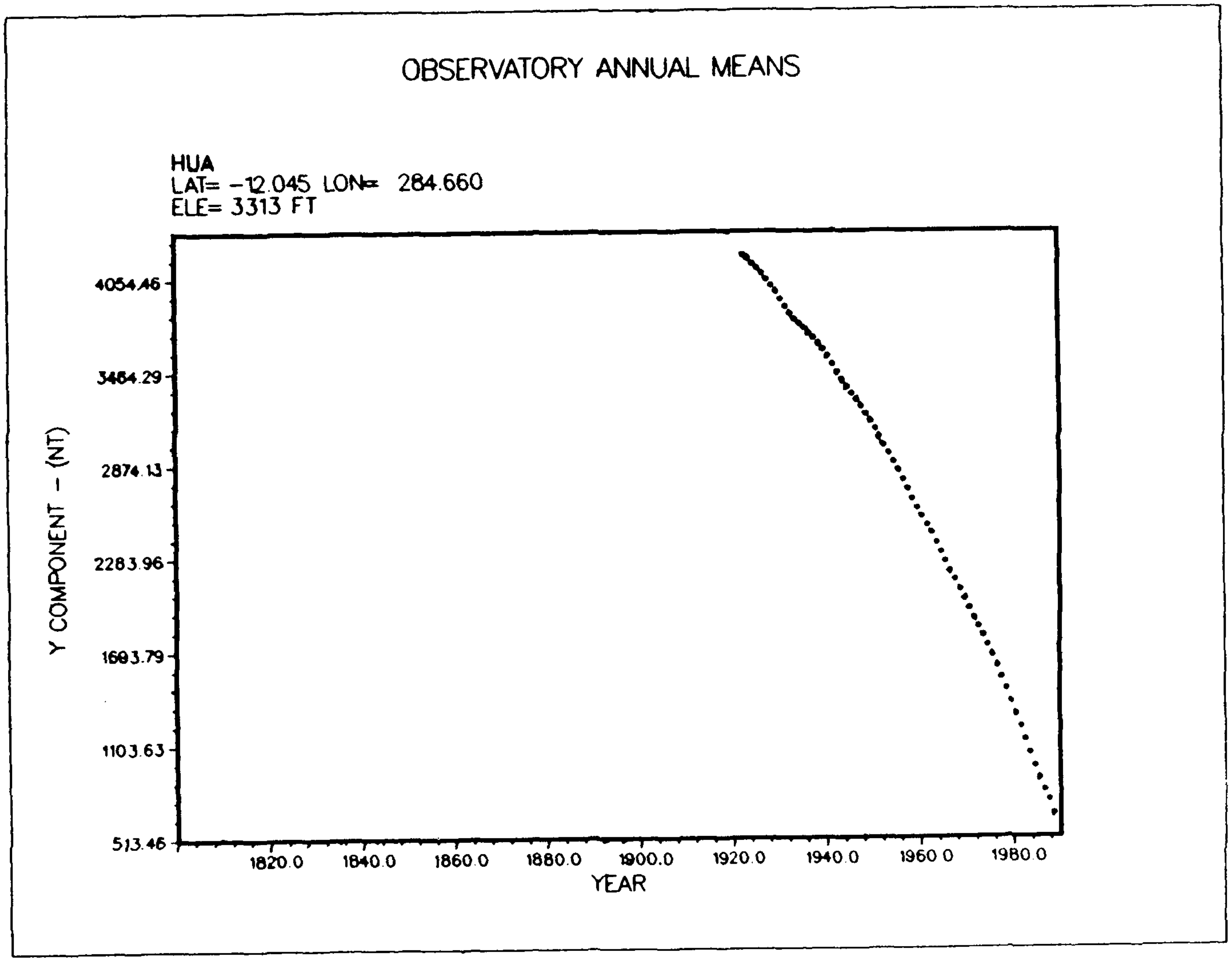


FIGURE 2b. EAST Y COMPONENT AT HUANCAYO (HUA).

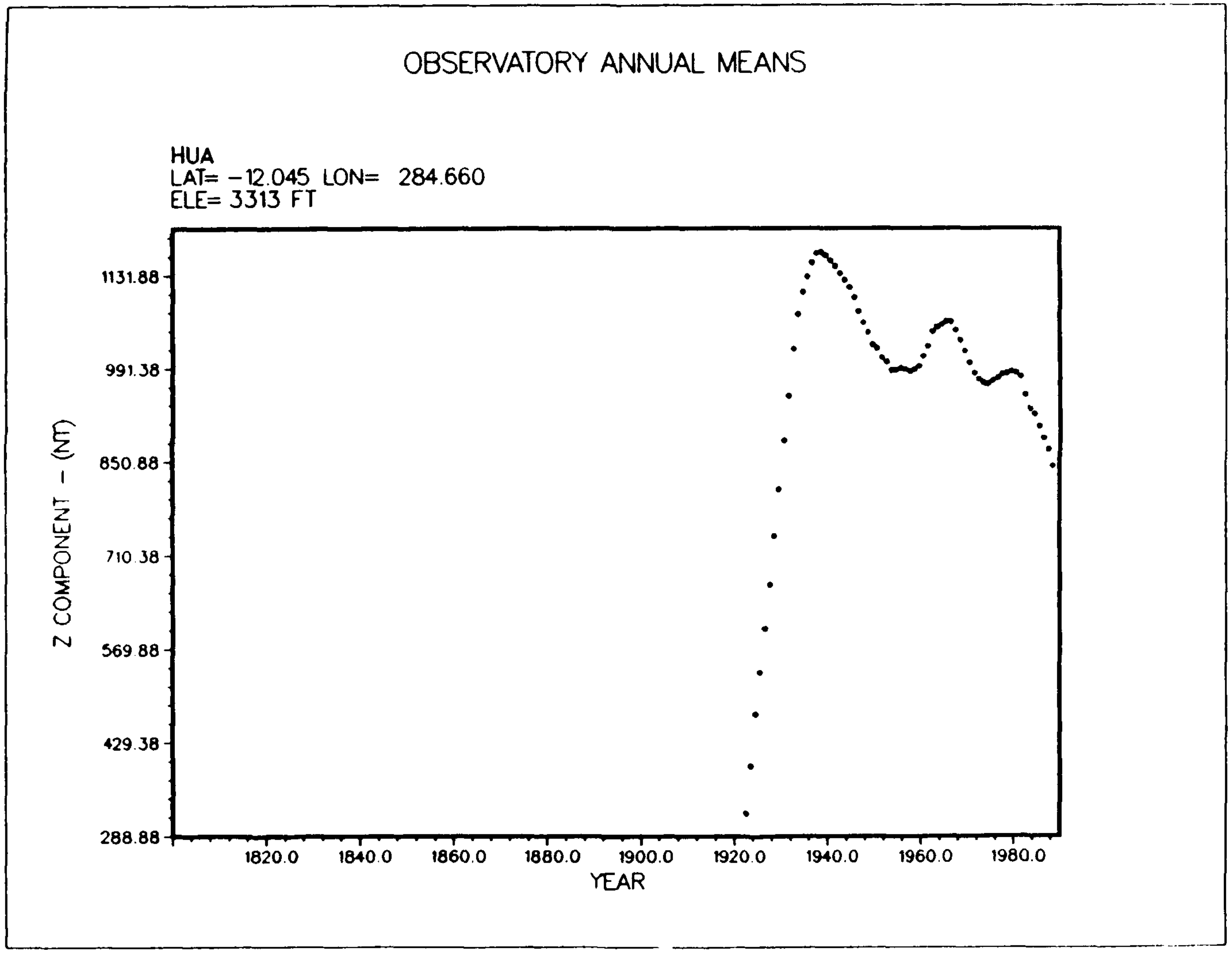


FIGURE 2c. VERTICAL Z COMPONENT AT HUANCAYO (HUA).

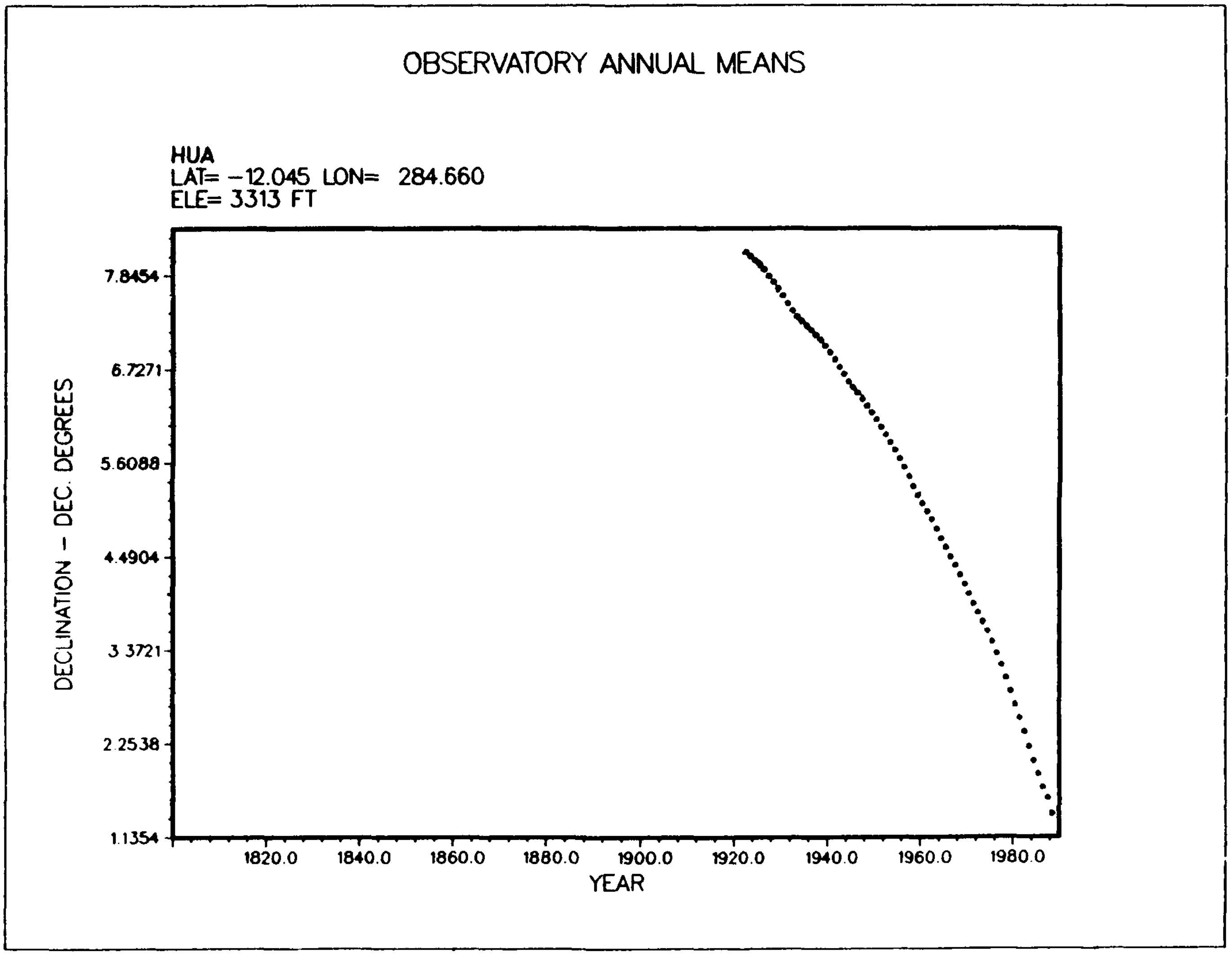


FIGURE 2d. DECLINATION D COMPONENT AT HUANCAYO (HUA).

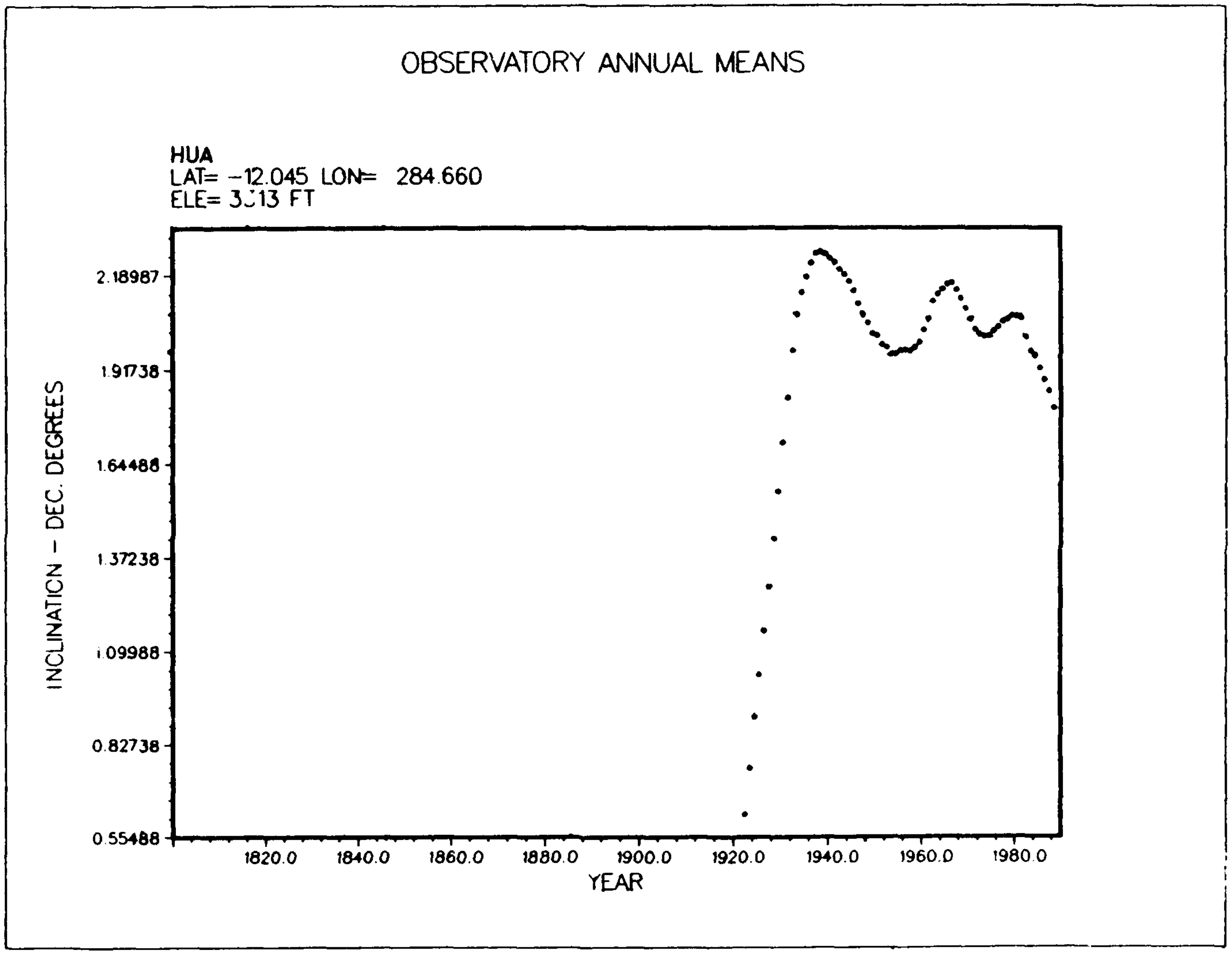


FIGURE 2c. INCLINATION I COMPONENT AT HUANCAYO (HUA).

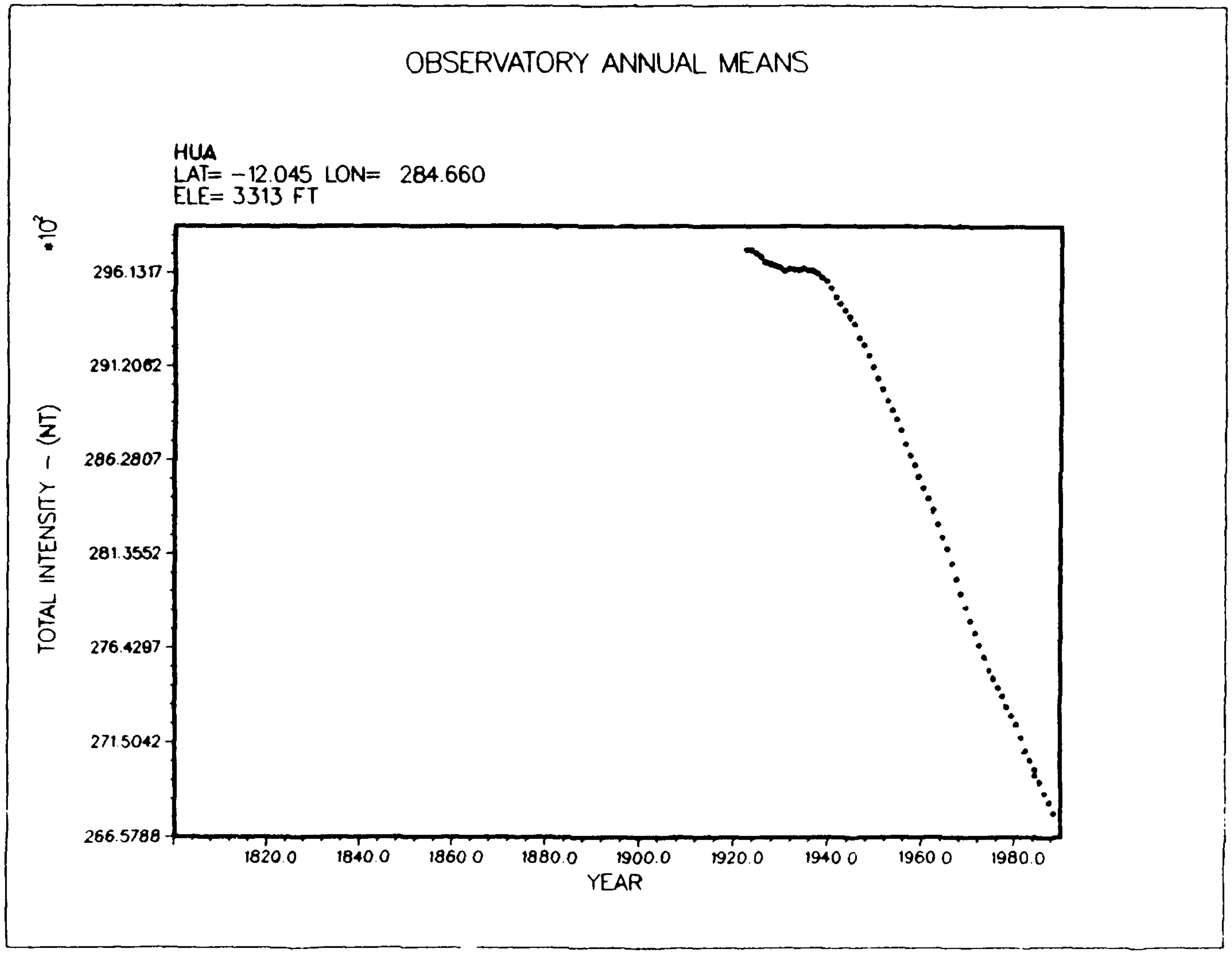


FIGURE 2f. TOTAL INTENSITY F COMPONENT AT HUANCAYO (HUA).

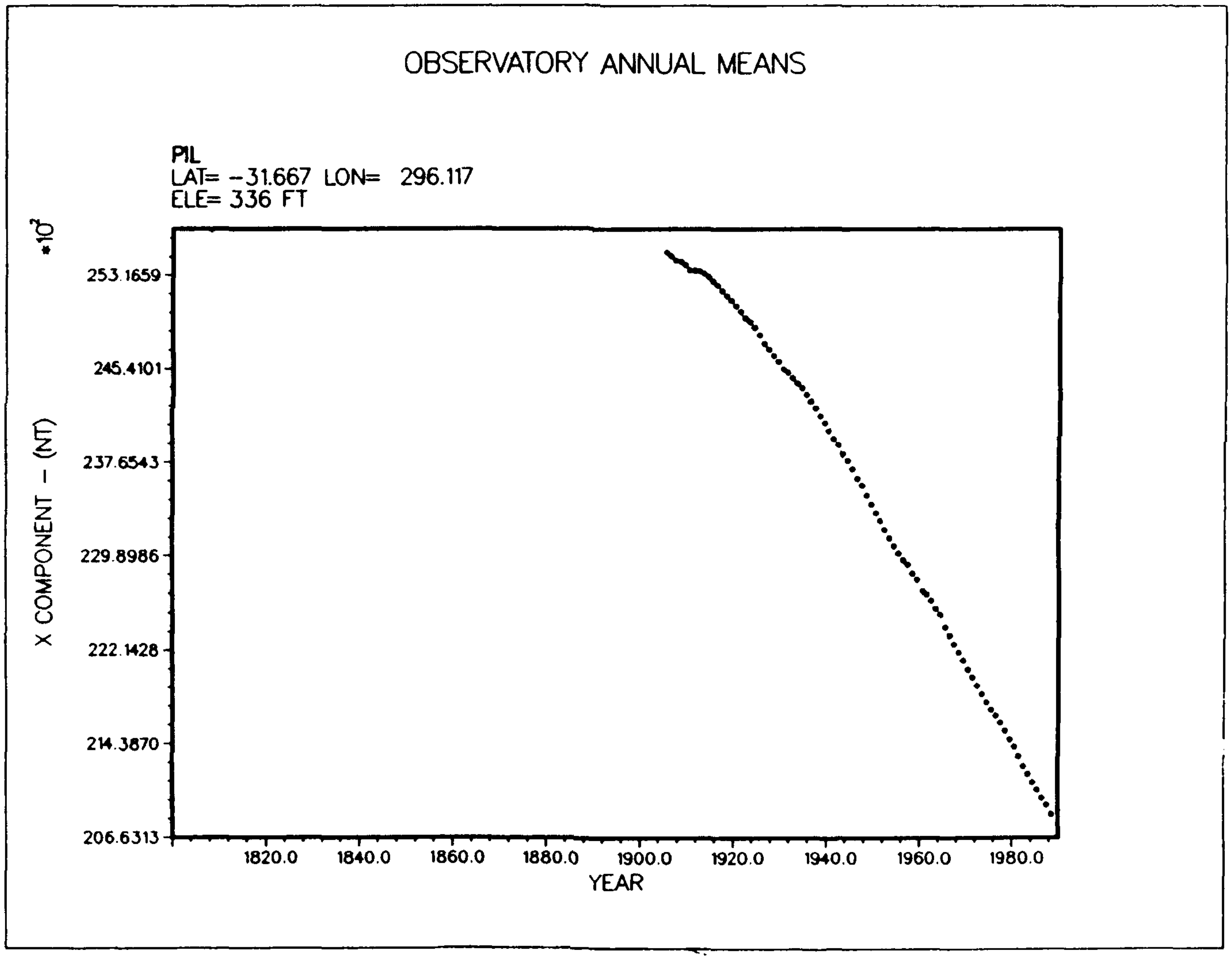


FIGURE 3a. NORTH X COMPONENT AT PILAR (PIL).

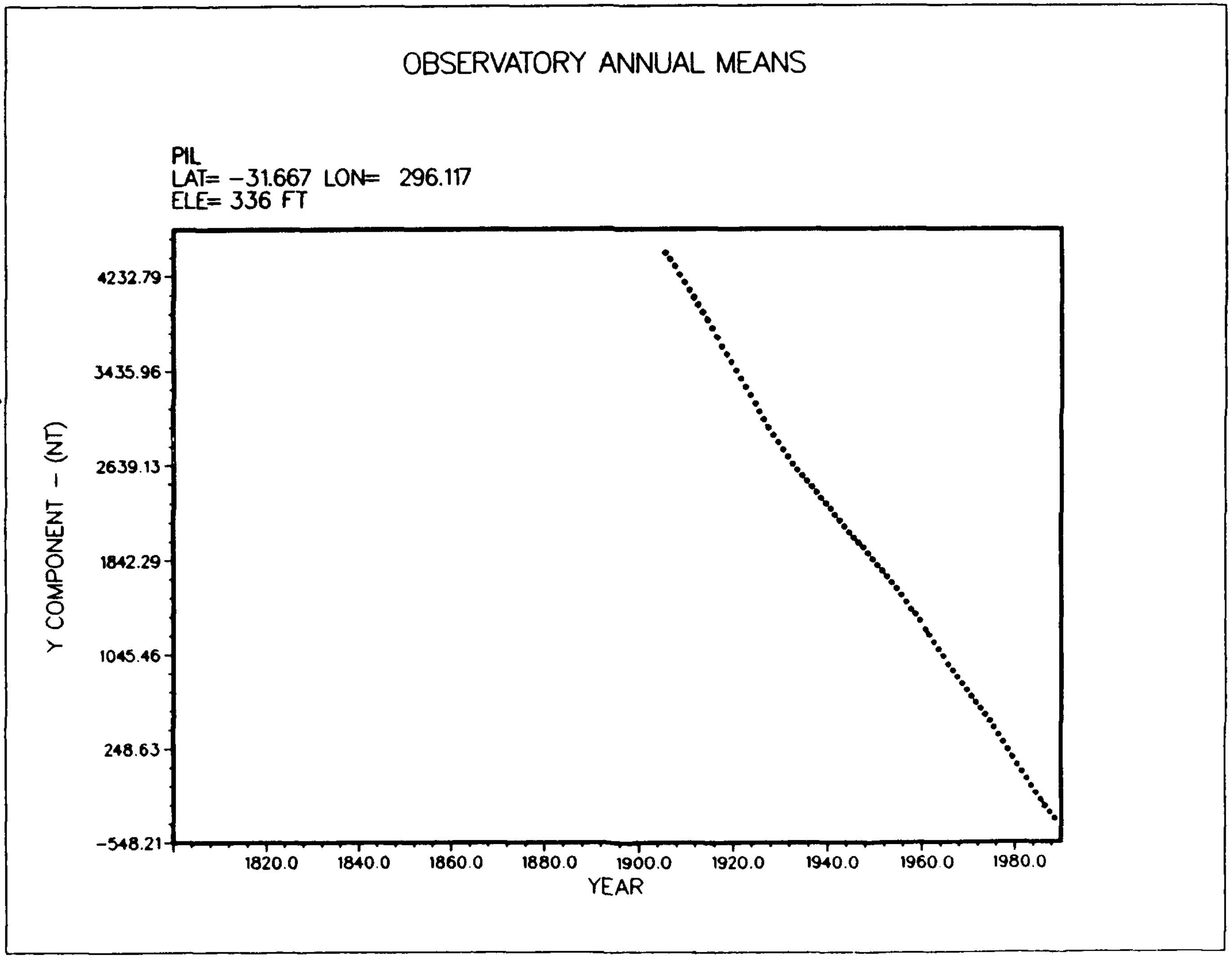


FIGURE 3b. EAST Y COMPONENT AT PILAR (PIL).

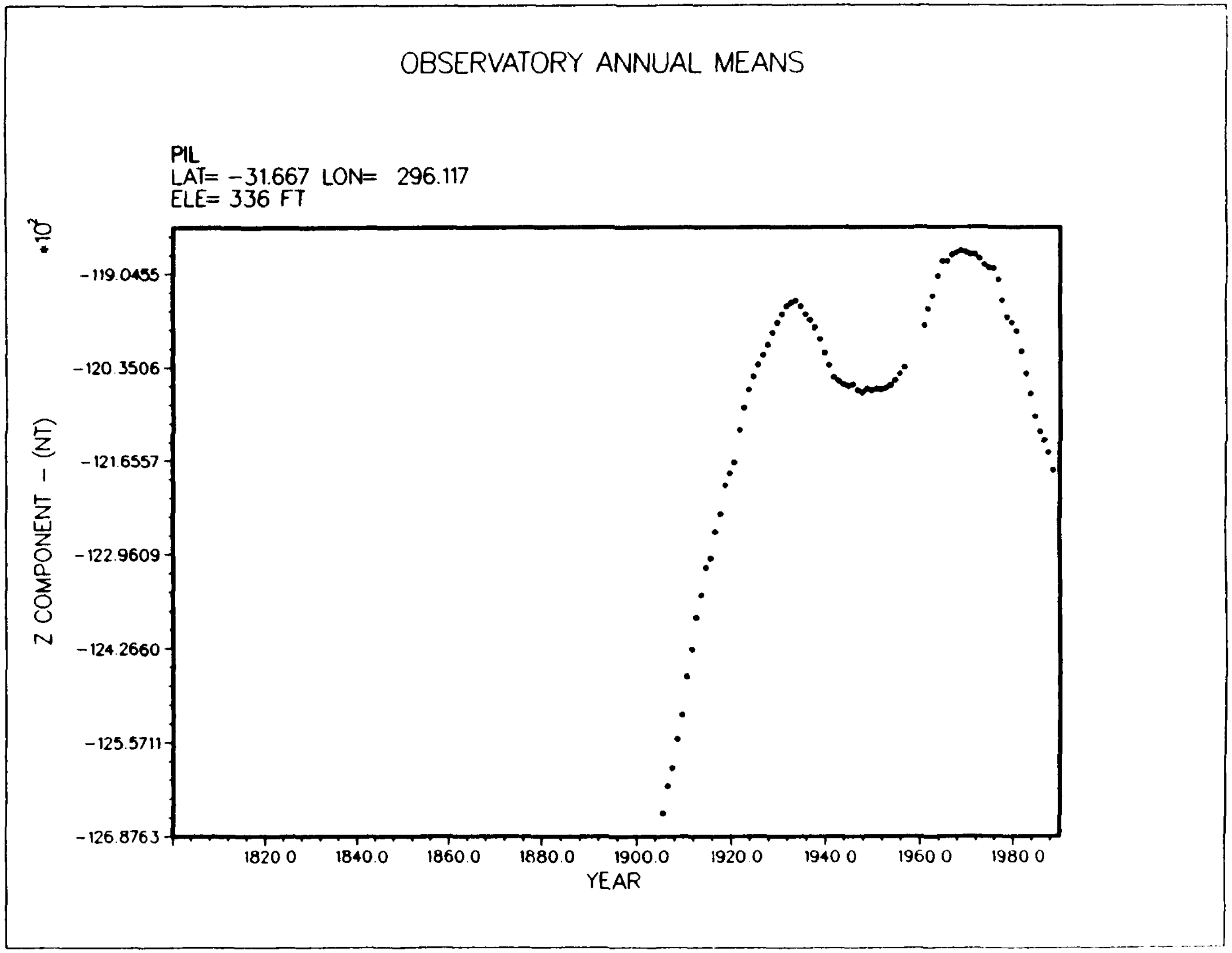


FIGURE 3c. VERTICAL Z COMPONENT AT PILAR (PIL).

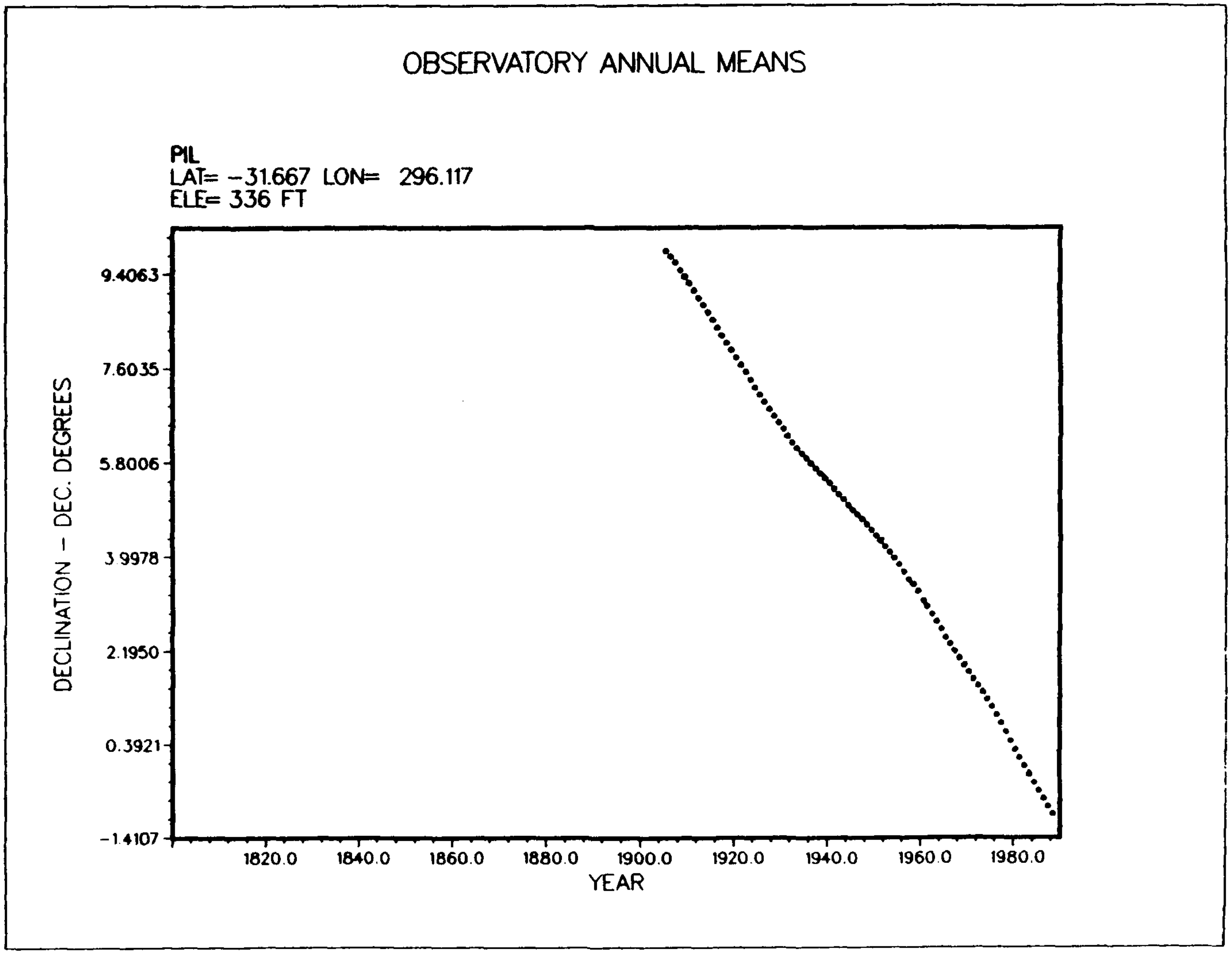


FIGURE 3d. DECLINATION D COMPONENT AT PILAR (PIL).

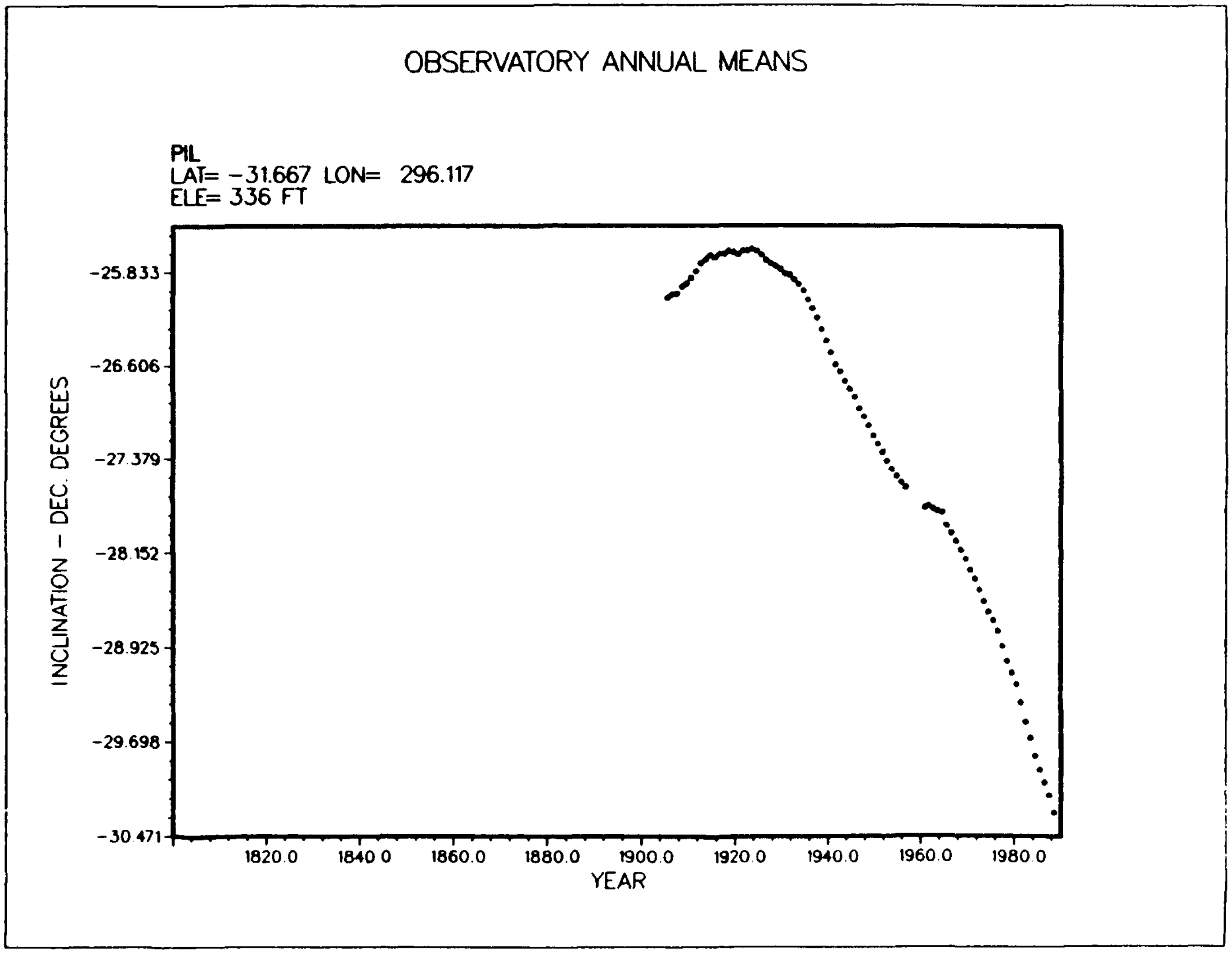


FIGURE 3c. INCLINATION I COMPONENT AT PILAR (PIL).

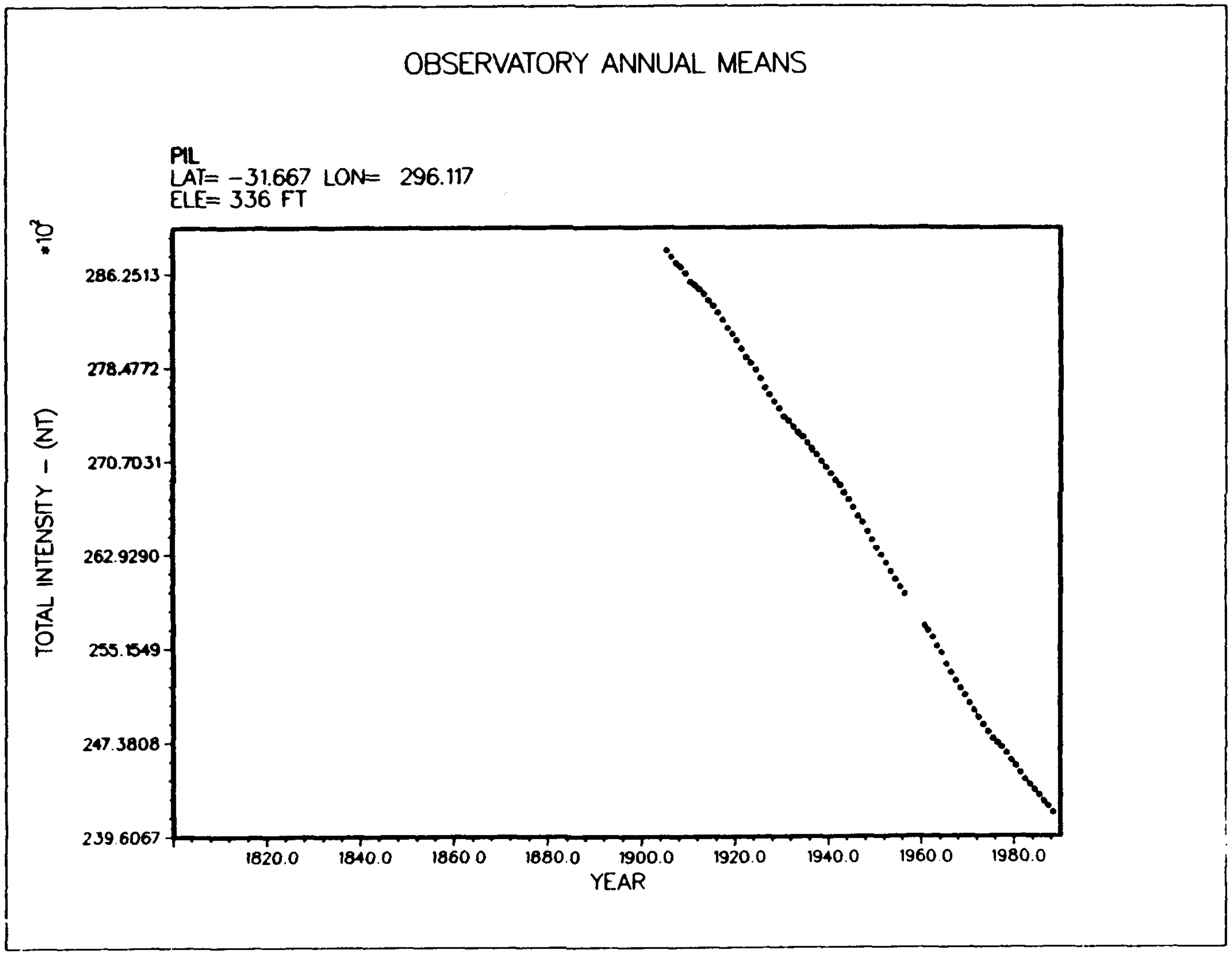


FIGURE 3f. TOTAL INTENSITY F COMPONENT AT PILAR (PIL).

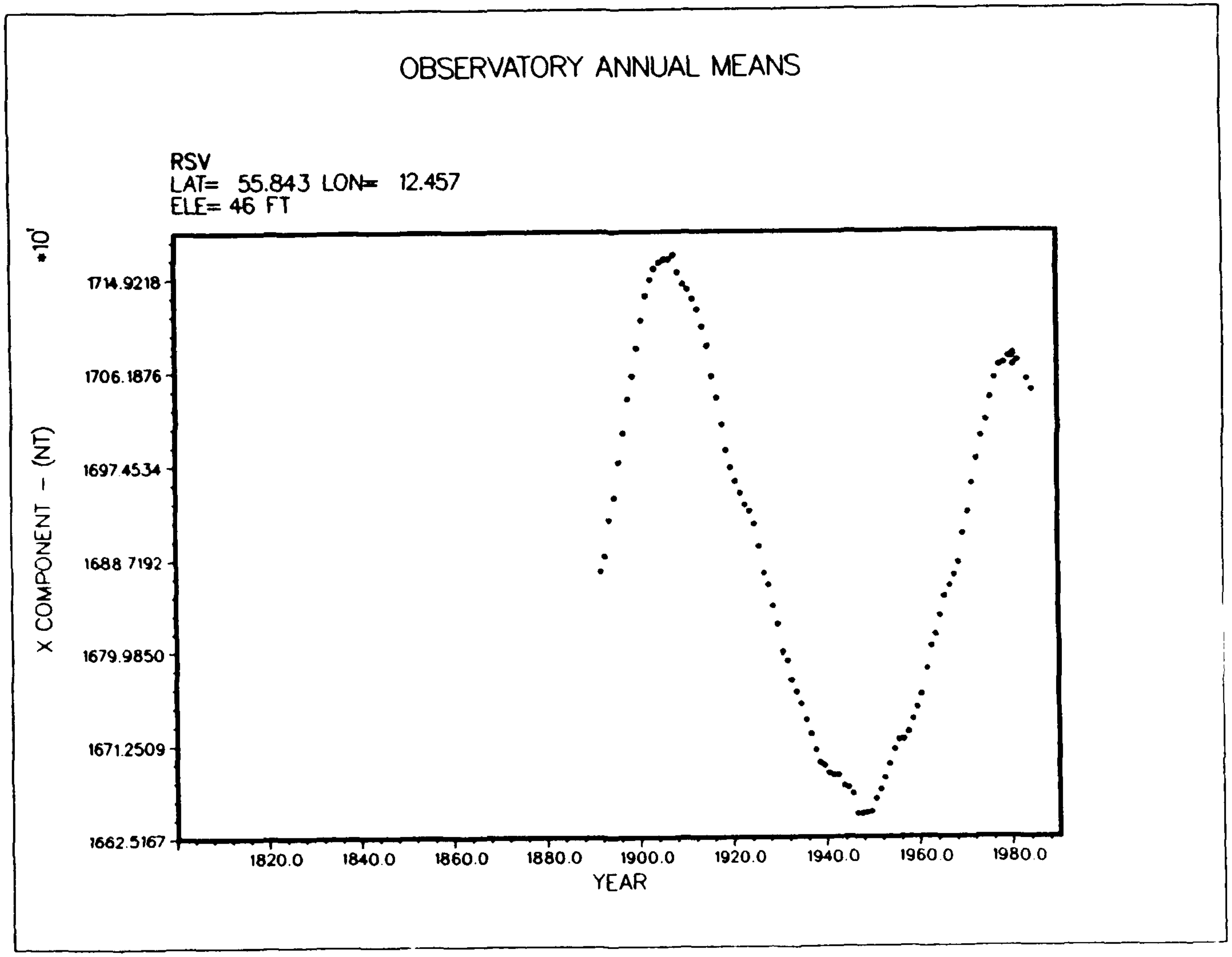


FIGURE 4a. NORTH X COMPONENT AT RUDE SKOV (RSV).

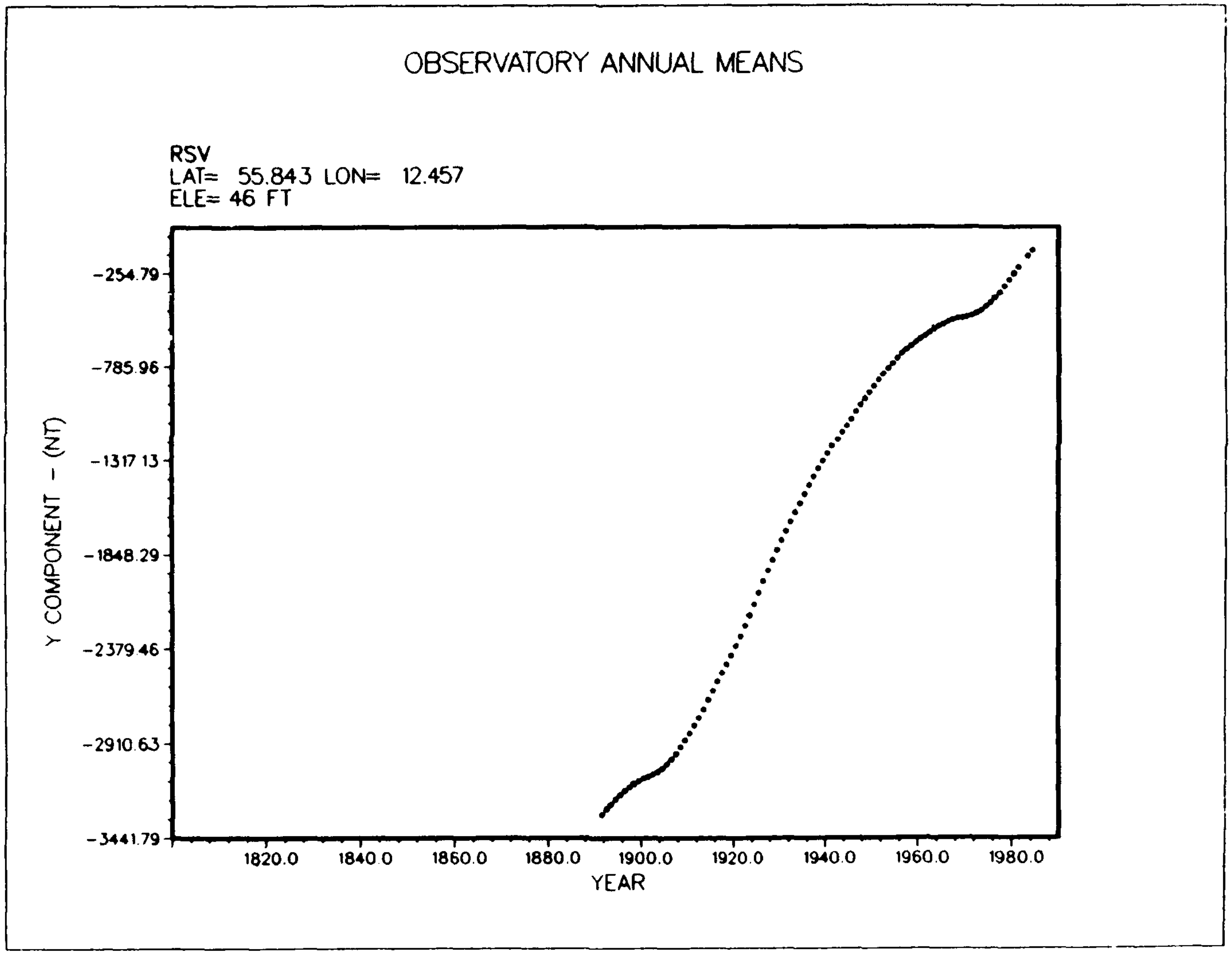


FIGURE 4b. EAST Y COMPONENT AT RUDE SKOV (RSV).

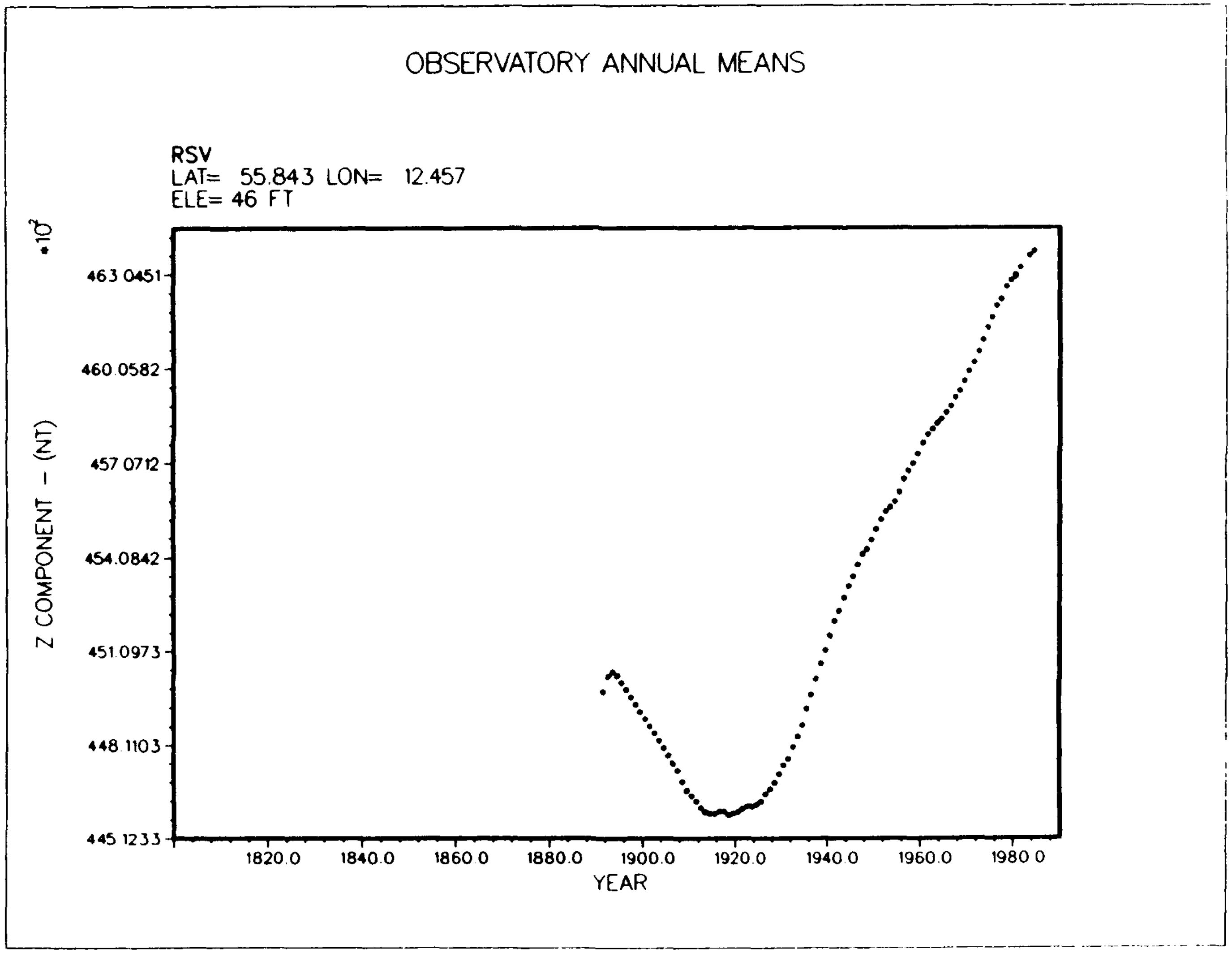


FIGURE 4c. VERTICAL Z COMPONENT AT RUDE SKOV (RSV).

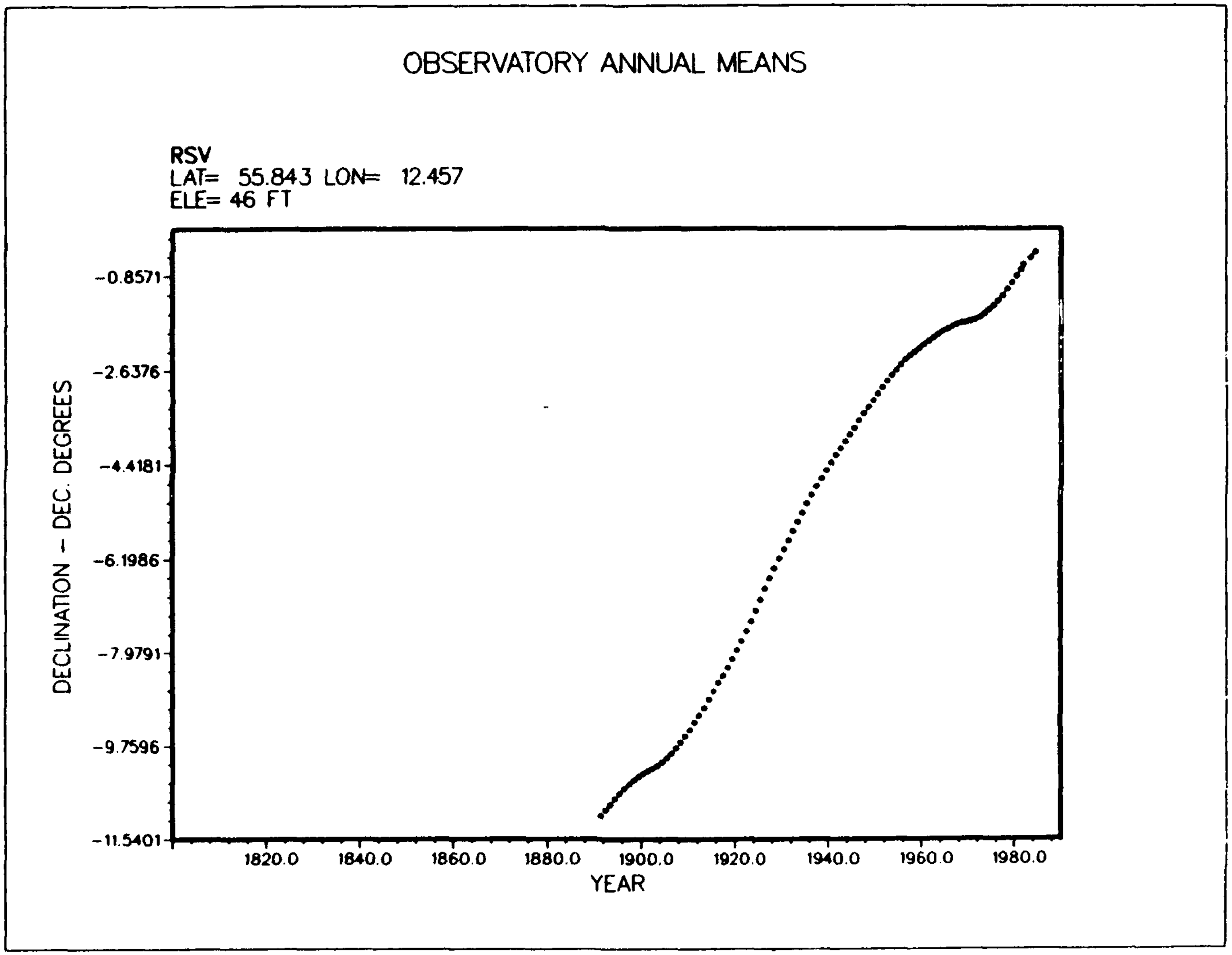


FIGURE 4d. DECLINATION D COMPONENT AT RUDE SKOV (RSV).

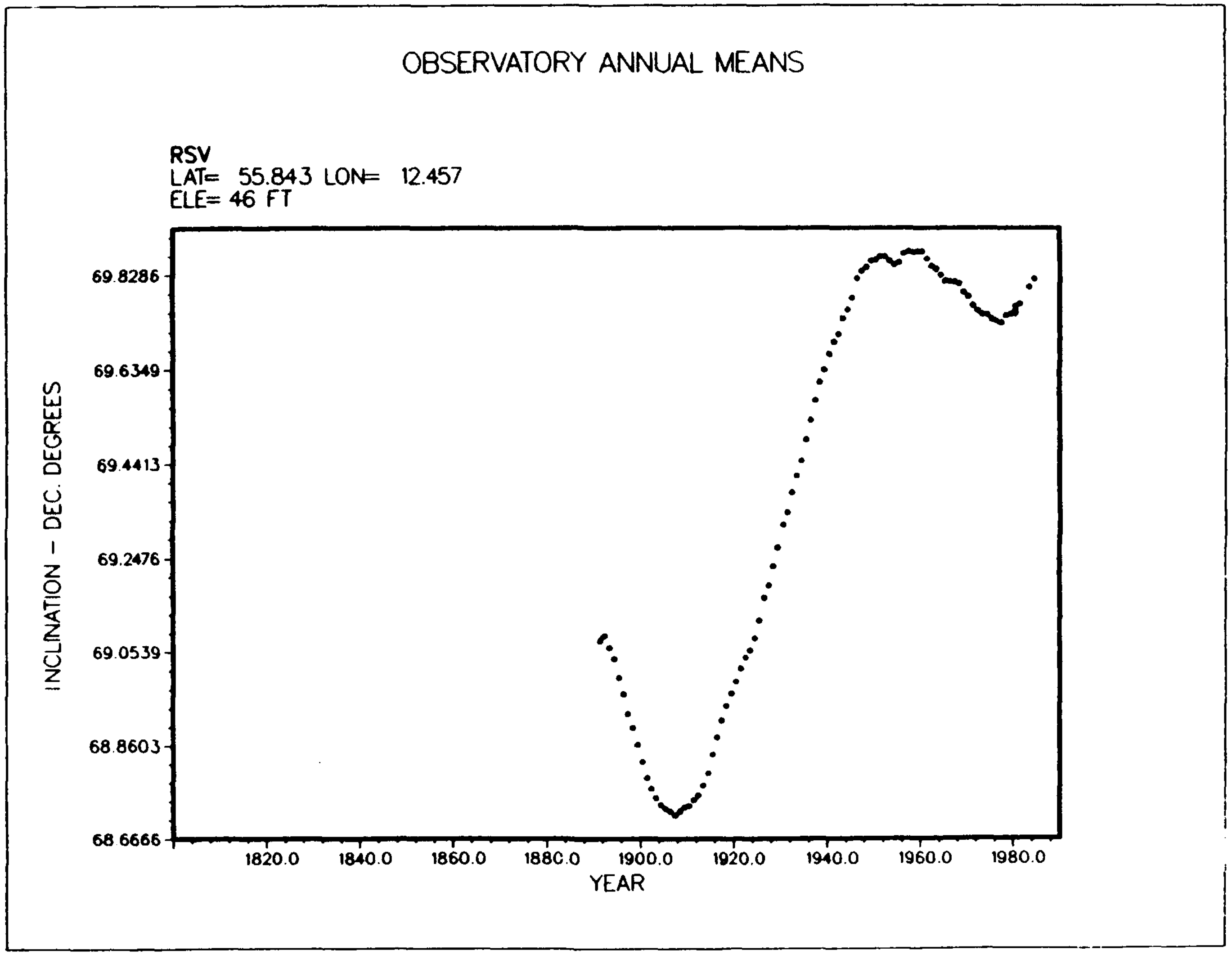


FIGURE 4c. INCLINATION I COMPONENT AT RUDE SKOV (RSV).

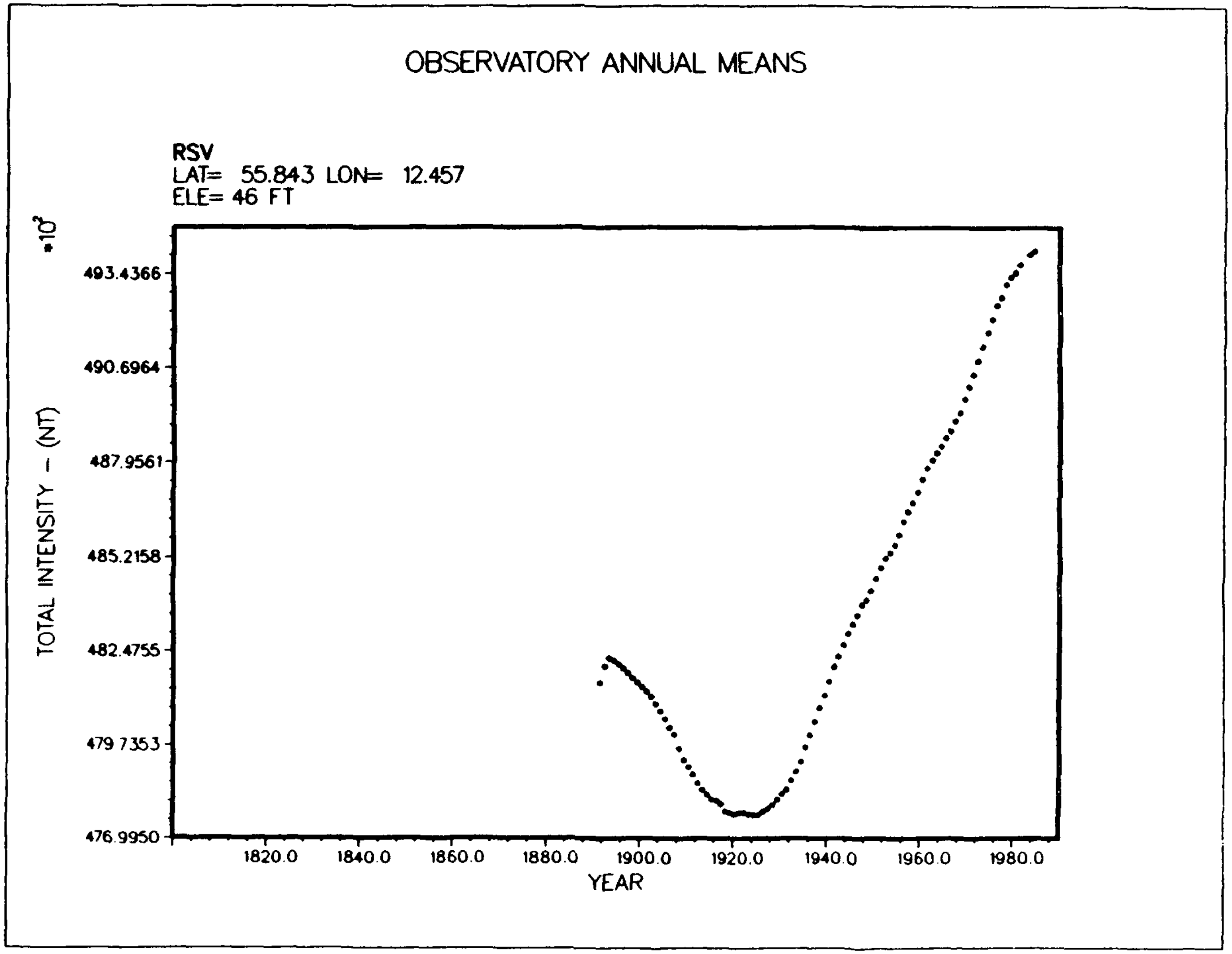


FIGURE 4f. TOTAL INTENSITY F COMPONENT AT RUDE SKOV (RSV).

Three secular variation models are generated by performing a weighted, least-square fit of the degree and order 8 spherical harmonic model to the first-order time derivative of the observatory annual means. These models were supplied by the British Geological Survey and are given in table 4.

2.2 Main Field Data Analysis (United States Responsibility)

The observatory annual magnetic means were not used in the main field modeling because those data contain, in addition to small external field contributions, some rather large local and regional magnetic biases of crustal origin. A detailed survey at each observatory site would be necessary to remove these biases. Such surveys have rarely been performed due to the prohibitive cost, logistics, and international politics involved.

The MAGSAT data consisted of 30,473 vector magnetic field values selected from 401 of the first 804 orbits. To minimize solar influences, the $\mathbf{K}_p$ magnetic index was required to be equal to, or less than, 2 ($\mathbf{K}_p \leq 2$). These orbits were individually edited by an interactive graphics process to delete field aligned current effects and spurious data. Also, the following corrections for magnetospheric effects due to the ring current, magnetopause currents, and magnetotail currents were applied:

$$\mathrm{B}_X(r,\theta,\phi,\tau) = -\ q_1^0(\tau)\sin\theta + \{q_1^1(\tau)\cos\phi + s_1^1(\tau)\sin\phi\}\cos\theta \tag{21a}$$

$$\mathrm{B}_Y(r,\theta,\phi,\tau) = q_1^1(\tau)\sin\phi - s_1^1(\tau)\cos\phi \tag{21b}$$

$$\mathrm{B}_Z(r,\theta,\phi,\tau) = q_1^0(\tau)\cos\theta + \{q_1^1(\tau)\cos\phi + s_1^1(\tau)\sin\phi\}\sin\theta \tag{21c}$$

where the time-dependent coefficients are functions of the Disturbance Storm Time (*Dst*) index:

$$q_1^0(\tau) = 19.69 - 0.63Dst(\tau) \tag{22a}$$

$$q_1^1(\tau) = -0.38 - 0.06Dst(\tau) \tag{22b}$$

$$s_1^1(\tau) = -2.90 + 0.17Dst(\tau) \tag{22c}$$

These corrections are derived from the external magnetic field potential:

TABLE 4. SECULAR VARIATION MODELS (units: nanotesles/year)

		1982.5 Epoch		1987.5 Epoch		1992.5 Epoch	
n	m	$\dot{g}_n^m$	$\dot{h}_n^m$	$\dot{g}_n^m$	$\dot{h}_n^m$	$\dot{g}_n^m$	$\dot{h}_n^m$
1	0	22.601	0.000	18.745	0.000	16.013	0.000
1	1	10.491	-20.091	10.554	-17.836	9.259	-13.759
2	0	-14.454	0.000	-12.552	0.000	-11.703	0.000
2	1	3.389	-14.476	3.290	-15.523	3.715	-12.790
2	2	5.043	-20.686	0.656	-15.631	1.767	-14.865
3	0	2.839	0.000	3.644	0.000	2.115	0.000
3	1	-5.747	4.810	-6.918	4.285	-7.596	3.082
3	2	-1.857	3.013	0.000	1.498	0.000	0.844
3	3	-1.130	-10.049	-4.759	-10.351	-5.815	-11.342
4	0	0.000	0.000	0.000	0.000	-0.770	0.000
4	1	0.000	5.277	0.483	3.375	0.968	3.281
4	2	-6.929	1.770	-7.391	2.994	-7.414	3.680
4	3	0.000	4.323	0.510	3.812	0.775	2.799
4	4	-6.192	0.771	-5.343	0.000	-6.361	0.000
5	0	0.952	0.000	0.808	0.000	1.662	0.000
5	1	-0.577	0.000	-0.357	-0.593	0.000	0.000
5	2	-1.578	-0.402	-1.730	0.000	0.000	-2.096
5	3	-3.916	-0.501	-3.250	0.000	-2.699	1.226
5	4	0.000	0.000	0.000	1.712	0.000	1.193
5	5	1.018	0.532	2.001	0.464	3.001	0.650
6	0	0.962	0.000	1.296	0.000	0.751	0.000
6	1	0.000	-1.107	0.000	0.000	0.000	-0.583
6	2	1.678	-0.821	1.799	-1.277	1.451	-0.644
6	3	0.755	-0.428	0.834	0.000	0.000	0.000
6	4	0.000	-0.954	-0.667	-1.664	0.000	-2.266
6	5	0.000	0.349	0.000	0.000	0.000	0.000
6	6	1.437	0.456	0.663	1.381	0.000	0.000
7	0	0.376	0.000	0.670	0.000	0.505	0.000
7	1	-0.645	0.223	-0.483	0.978	0.000	0.599
7	2	0.457	0.321	0.000	0.000	-0.869	0.793
7	3	1.020	0.375	1.010	0.390	1.457	0.000
7	4	1.583	0.880	1.903	0.000	2.650	0.000
7	5	0.893	0.000	0.597	0.000	-1.020	0.000
7	6	0.387	0.467	0.000	0.000	0.000	0.417
7	7	0.000	0.825	0.543	0.000	0.000	0.000
8	0	0.651	0.000	0.237	0.000	0.000	0.000
8	1	0.000	0.459	-0.692	0.399	-1.089	0.427
8	2	-0.176	-0.332	-0.367	-0.195	0.000	-0.809
8	3	0.000	0.330	0.000	0.586	0.000	0.507
8	4	-0.842	-0.268	-1.292	0.519	-2.114	0.349
8	5	-0.222	0.428	0.000	0.526	0.000	0.499
8	6	0.000	-0.967	0.423	-0.742	0.978	0.000
8	7	-0.394	-0.994	0.000	-0.713	0.000	-0.684
8	8	-0.516	0.693	-0.562	0.0000	0.000	0.000

$$V_{ext}(r,\theta,\phi,\tau) = a\sum_{n=1}^{N_{ext}}\sum_{m=0}^{n}\left(\frac{r}{a}\right)^{n}\{q_n^m(\tau)\cos m\phi + s_n^m(\tau)\sin m\phi\}P_n^m(\cos\theta) \qquad (23)$$

when $N_{ext}=1$, via the relations:

$$B_X = -B_\theta = \frac{1}{r}\frac{\partial V}{\partial\theta} \qquad (24a)$$

$$B_Y = +B_\phi = -\frac{1}{r\sin\theta}\frac{\partial V}{\partial\phi} \qquad (24b)$$

$$B_Z = -B_r = \frac{\partial V}{\partial r} \qquad (24c)$$

A further correction takes into account the magnetic fields induced in the Earth by the external fields which, because of their time dependence and the generally low but finite conductivity of the crust and mantle, induce electric currents in the crust and mantle, which in turn generate secondary magnetic fields. These secondary fields are of internal origin and primarily affect the g_1^0 coefficients of the internal magnetic potential:

$$V_{int}(r,\theta,\phi,\tau) = a\sum_{n=1}^{N_{int}}\sum_{m=0}^{n}\left(\frac{a}{r}\right)^{n+1}\{g_n^m(\tau)\cos m\phi + h_n^m(\tau)\sin m\phi\}P_n^m(\cos\theta) \qquad (25)$$

Taking derivatives as before with $n=1$ and $m=0$, the magnetic field corrections due to induction effects are:

$$B_X(r,\theta,\phi,\tau) = -\left(\frac{a}{r}\right)^3 g_{1I}^0(\tau)\sin\theta \qquad (26a)$$

$$B_Y(r,\theta,\phi,\tau) = 0 \qquad (26b)$$

$$B_Z(r,\theta,\phi,\tau) = -2\left(\frac{a}{r}\right)^3 g_{1I}^0(\tau)\cos\theta \qquad (26c)$$

where the induced part of the g_1^0 coefficient is given as:

$$g_{1I}^0(\tau) = 0.27q_1^0(\tau) \qquad (27)$$

The external and induced magnetic field corrections given above were subtracted from the MAGSAT observations. These corrections are based on previous analyses of MAGSAT data by Langel and Estes (1985) and by Quinn, Kerridge, and Barraclough (1986).

No attempts were made to remove magnetic influences due to ionospheric currents such as those generated by solar quiet (*SQ*) currents, auroral electrojet currents, and equatorial electrojet currents, which are located below the MAGSAT orbit altitudes. These influences, though generated external to the Earth's surface, are nevertheless part of $V_{int}(r,\theta,\phi,\tau)$ because their sources are internal to the point of observation. Consequently, separating core-generated fields from crustal and ionospherically generated fields measured by satellite magnetometers is difficult and is still a research matter. Fortunately, fields generated in the Earth's crust and ionosphere are significantly attenuated at satellite altitudes. Therefore, errors in the main field model coefficients due to contamination of the satellite data by these two sources are comparatively small.

MAGSAT was a joint National Aeronautics and Space Administration (NASA)/U.S. Geological Survey mission. These data were supplied by NASA in the form of investigator B tapes.

The DE-2 satellite data set consisted of 5,100 data points gleaned from the low-altitude end of a comparatively eccentric orbit. This data set contained only scalar total intensity measurements of the Earth's magnetic field. However, this data set exhibited a substantially higher rms error relative to the DGRF-80 model than the MAGSAT data. Consequently, for this and other reasons, the DE-2 data were not used in the final main field model determination. This data set originated with M. Sugiura of Japan (formerly of NASA). It was edited by J.R. Ridgeway of Science Applications Research Corporation and it was subsequently supplied to NAVOCEANO by Dr. Robert Langel of NASA.

The Project MAGNET aeromagnetic data consisted of 338 high-level flights (≥ 15,000 feet) of vector component measurements. These data are routinely processed by NAVOCEANO at a 2-second sample rate and sent to the National Geophysical Data Center (NGDC) in Boulder, Colorado. A weak low-pass filter with a cut-off wavelength of approximately 7 km is routinely applied to this high-level data. The cut-off wavelength will vary slightly, depending on the average speed of the aircraft, which depends on prevailing wind conditions at the time of flight. Typical flights last 10 to 12 hours and are flown at an average speed of 440 km/hr. They are generally flown at night in order to minimize solar-driven external field effects which contribute to the Daily Variation (*DV*) of the Earth's field. Project MAGNET flights are of long range in remote ocean areas, which precludes the monitoring of *DV*. Therefore, no explicit *DV* corrections are

made to the data. Also, the aircraft's vector magnetometer is calibrated at the NASA Coil Room Facility at the Goddard Space Flight Center in Maryland at least once a year.

The magnetic field observations returned from each Project MAGNET flight are routinely reduced in accordance with the following procedures:

a. Rotate vector measurements from magnetometer coordinates to instantaneous aircraft coordinates. This rotation involves only small misalignments relative to an imaginary coordinate system rigidly attached to the aircraft.

b. Compensate in aircraft coordinates for the perturbing magnetic effects associated with the presence of the aircraft by removing a field phenomenologically modeled as:

$$\vec{B}_C(\tau) = \vec{B}_{Perm} + \overleftrightarrow{\alpha}\ \vec{B}_M(\tau) + \overleftrightarrow{\beta}\ \frac{d\vec{B}_M(\tau)}{d\tau} \tag{28}$$

where the first term represents the permanent magnetic field generated by the remnant magnetization of the aircraft's metal parts, the second term represents the field induced in the aircraft's metal structure by the presence of the ambient field $\vec{B}_M(\tau)$, and the third term represents magnetic fields generated by eddy currents created on the aircraft's metal surfaces by the aircraft's motion through the Earth's spatially varying field. Here, $B_M(\tau)$ is the magnetic field measured by the magnetometer after it has been rotated into aircraft coordinates as indicated in step a. The compensation model contains 21 coefficients, 3 in the vector $\vec{B}_{Perm}$, 9 in the 3x3 matrix $\overleftrightarrow{\alpha}$, and 9 in the 3x3 matrix $\overleftrightarrow{\beta}$.

c. Rotate the compensated field from instantaneous aircraft coordinates to geodetic coordinates, taking into account the misalignment of the inertial attitude device relative to the instantaneous aircraft coordinates.

d. Visually edit the data in each flight via interactive graphics techniques.

The compensation coefficients are determined by performing calibration flights at an altitude of 1,500 feet above a designated magnetic observatory. These flights consist of a set of yaw, pitch, and roll maneuvers performed along the four cardinal headings (north, south, east, and west). The coefficients are then determined by a least-squares procedure that minimizes the squared difference between

the observatory field (upward continued and rotated into instantaneous aircraft coordinates using the inertial attitude devices on the aircraft) and the field measured by the aircraft's magnetometer.

Using this minimization technique, the 21 compensation coefficients are determined simultaneously with 6 Euler angles (3 for the magnetometer misalignment mentioned in step a and 3 for the inertial attitude device misalignment mentioned in step c. The overall process is, therefore, nonlinear, requiring several iterations to converge. Note, however, that it is possible to determine only the relative misalignment between the magnetometer axes and the inertial system axes. Therefore, the three magnetometer bias angles are arbitrarily set to zero so that, in practice, only the three inertial system bias angles (Euler angles) are computed.

After compensation and editing, the aeromagnetic data were decimated to a 200-second sample interval (i.e., every hundredth point was selected), yielding 54,656 vector magnetic observations. The resulting Project MAGNET data set was finally converted from geodetic coordinates to spherical coordinates, using the coordinate transformations of the previous section.

For modeling, it is desirable to have all data sets pushed forward or backward to a common epoch. Consequently, the MAGSAT data set, which was originally in spherical coordinates, was pushed forward to 1985.0 via the 1982.5 secular variation model. The portion of the Project MAGNET data set collected prior to 1985.0 was pushed forward to 1985.0 via the 1982.5 secular variation model, while the portion of the Project MAGNET data set collected after 1985.0 was pushed backward to 1985.0 by the 1987.5 secular variation model. Subsequently, a revised 1985.0 epoch main field model was generated by performing a weighted least-squares fit of the degree and order 12 spherical harmonic model to the combined MAGSAT and Project MAGNET data sets. The resulting main field model, when combined with the 1987.5 secular variation model, is referred to as WC-85 (revised). These coefficients are listed in table 5. The 1990.0 main field model was produced by pushing the WC-85 (revised) main field spherical harmonic coefficients forward in time using the 1987.5 secular variation coefficients. The resulting 1990.0 epoch main field model was then combined with the 1992.5 secular variation model to form WMM-90, the coefficients of which are listed in table 3 of section 1.3.

2.3 Mathematical Details of Main Field Inverse Modeling

The modeling procedure used was a modification of that formulated by Cain et al. (1967). The objective was to minimize the chi-square (χ^2) function

$$\chi^2 = \chi_r^2 + \chi_\theta^2 + \chi_\phi^2 + \chi_F^2 \qquad (29)$$

TABLE 5. WC-85 (REVISED) SCHMIDT NORMALIZED GAUSS COEFFICIENTS

n	m	g_n^m (nT)	h_n^m (nT)	$\dot{g}_n^m$ (nT/yr)	$\dot{h}_n^m$ (nT/yr)
1	0	-29874.2	.0	18.7	.0
1	1	-1904.5	5496.4	10.6	-17.8
2	0	-2071.6	.0	-12.6	.0
2	1	3045.7	-2200.6	3.3	-15.5
2	2	1688.7	-306.1	.7	-15.6
3	0	1294.7	.0	3.6	.0
3	1	-2210.1	-306.4	-6.9	4.3
3	2	1246.8	284.2	.0	1.5
3	3	832.4	-300.7	-4.8	-10.4
4	0	933.5	.0	.0	.0
4	1	782.5	232.5	.5	3.4
4	2	360.5	-247.6	-7.4	3.0
4	3	-424.2	72.2	.5	3.8
4	4	166.0	-296.5	-5.3	.0
5	0	-212.3	.0	.8	.0
5	1	354.0	43.7	-.4	-.6
5	2	255.2	148.7	-1.7	.0
5	3	-94.6	-154.6	-3.3	.0
5	4	-162.3	-76.2	.0	1.7
5	5	-47.2	95.0	2.0	.5
6	0	52.5	.0	1.3	.0
6	1	63.7	-14.7	.0	.0
6	2	51.0	88.6	1.8	-1.3
6	3	-185.4	70.0	.8	.0
6	4	3.8	-47.8	-.7	-1.7
6	5	15.4	-1.4	.0	.0
6	6	-99.3	17.7	.7	1.4
7	0	72.8	.0	.7	.0
7	1	-59.7	-83.5	-.5	1.0
7	2	1.3	-26.7	.0	.0
7	3	25.1	-1.9	1.0	.4
7	4	-4.8	19.9	1.9	.0
7	5	4.9	17.9	.6	.0
7	6	10.1	-21.5	.0	.0
7	7	-.8	-6.8	.5	.0

TABLE 5. WC-85 (REVISED) SCHMIDT NORMALIZED GAUSS COEFFICIENTS (con.)

n	m	g_n^m (nT)	h_n^m (nT)	$\dot{g}_n^m$ (nT/yr)	$\dot{h}_n^m$ (nT/yr)
8	0	21.7	.0	.2	.0
8	1	5.8	7.7	-.7	.4
8	2	.6	-18.3	-.4	-.2
8	3	-11.7	3.7	.0	.6
8	4	-11.0	-22.7	-1.3	.5
8	5	2.2	10.8	.0	.5
8	6	3.6	13.5	.4	-.7
8	7	3.0	-15.4	.0	-.7
8	8	-4.2	-9.1	-.6	.0
9	0	3.6	.0	.0	.0
9	1	9.5	-21.9	.0	.0
9	2	-.9	14.3	.0	.0
9	3	-10.7	9.5	.0	.0
9	4	10.7	-6.7	.0	.0
9	5	-3.2	-6.4	.0	.0
9	6	-1.4	9.1	.0	.0
9	7	6.3	8.9	.0	.0
9	8	.8	-8.0	.0	.0
9	9	-5.5	2.1	.0	.0
10	0	-3.3	.0	.0	.0
10	1	-2.6	2.6	.0	.0
10	2	4.5	1.2	.0	.0
10	3	-5.6	2.6	.0	.0
10	4	-3.6	5.7	.0	.0
10	5	3.9	-4.0	.0	.0
10	6	3.2	-.4	.0	.0
10	7	1.7	-1.7	.0	.0
10	8	3.0	3.8	.0	.0
10	9	3.7	-.8	.0	.0
10	10	.7	-6.5	.0	.0

TABLE 5. WC-85 (REVISED) SCHMIDT NORMALIZED GAUSS COEFFICIENTS (con.)

n	m	g_n^m (nT)	h_n^m (nT)	$\dot{g}_n^m$ (nT/yr)	$\dot{h}_n^m$ (nT/yr)
11	0	1.3	.0	.0	.0
11	1	-1.4	.0	.0	.0
11	2	-2.5	1.0	.0	.0
11	3	3.2	-1.6	.0	.0
11	4	.2	-2.2	.0	.0
11	5	-1.1	1.1	.0	.0
11	6	.3	-.7	.0	.0
11	7	-.3	-1.7	.0	.0
11	8	.9	-1.5	.0	.0
11	9	-1.1	-1.3	.0	.0
11	10	2.4	-1.1	.0	.0
11	11	3.0	.6	.0	.0
12	0	-1.3	.0	.0	.0
12	1	.1	.7	.0	.0
12	2	.5	.7	.0	.0
12	3	.7	1.3	.0	.0
12	4	.4	-1.5	.0	.0
12	5	-.2	.3	.0	.0
12	6	-1.1	.2	.0	.0
12	7	.9	-1.1	.0	.0
12	8	-.6	1.2	.0	.0
12	9	.8	-.2	.0	.0
12	10	.2	-1.3	.0	.0
12	11	.4	.6	.0	.0
12	12	.2	.6	.0	.0

with respect to the 168 internal Gauss coefficients of a degree and order 12 spherical harmonic model, where:

$$\chi_r^2 = \sum_{i=1}^{I_r} w_{r_i}(B_{r_i} - b_{r_i})^2 \qquad (30a)$$

$$\chi_\theta^2 = \sum_{i=1}^{I_\theta} w_{\theta_i}(B_{\theta_i} - b_{\theta_i})^2 \qquad (30b)$$

$$\chi_\phi^2 = \sum_{i=1}^{I_\phi} w_{\phi_i}(B_{\phi_i} - b_{\phi_i})^2 \qquad (30c)$$

$$\chi_F^2 = \sum_{i=1}^{I_F} w_{F_i}(B_{F_i} - b_{F_i})^2 \qquad (30d)$$

where the upper case B's refer to the model values of their respective magnetic components, while the lower case *b*'s refer to the observed (measured) values of their respective magnetic components. The subscript *i* refers to a particular data point, the total number I of which may differ for each magnetic component. Each data point is weighted by a weight factor, *w*, which depends on several factors:

a. Data type W_m

MAGSAT = 1

Project MAGNET = 1/4

Project MAGNET observatory airswing calibrations yield rms errors on the order of 35 nT, while MAGSAT rms differences from degree 12 spherical harmonic models yield rms values on the order of 9 nT. Consequently, the relative weight of the two data sets is taken to be $\cong \frac{9}{35} \cong \frac{1}{4}$. This factor characterizes the relative quality of the two data sets.

b. The relative number of data points per equal area (5°x5° at the equator) cell; each cell was given equal weight. Therefore, data points corresponding to cells with more than the average number of points per cell, $\overline{N}$, received less weight and vice versa.

c. The relative rms error of data in a particular flight or orbit relative to the rms error, $\overline{\sigma}$, for all data of the corresponding data type (MAGSAT or Project MAGNET).

d. The relative rms error of data of a specified type in an equal area cell relative to all data of that type, $\bar{\sigma}$.

e. The age of the data relative to the model epoch 1985.0. Thus, data collected five years away from this epoch get a weight of approximately 1/3, while data collected at the model epoch get a weight of 1.

f. Distance of geomagnetic latitude, Θ, from the geomagnetic equator.

$$|\Theta_M| \le 20^\circ \quad \begin{Bmatrix} w_{\theta mn} & = & 1 & for & k=1,2,3(r,\theta,\phi) \\ w_{\theta mn} & = & 0 & for & k=4(F) \end{Bmatrix} \quad ; \quad n \equiv 1 \tag{31a}$$

$$|\Theta_M| > 20^\circ \quad \begin{Bmatrix} w_{\theta mn} & = & 0 & for & k=1,2,3(r,\theta,\phi) \\ w_{\theta mn} & = & 1 & for & k=4(F) \end{Bmatrix} \quad ; \quad n \equiv 2 \tag{31b}$$

This weighting scheme then takes the following mathematical form:

$$W_{ijklmn} = W_m w_{\theta_{mn}} \left(\frac{\overline{N}_{km}}{N_{kmj}} \right) \left(\frac{\bar{\sigma}_{km}}{\sigma_{kml}} \right) \left(\frac{\bar{\sigma}_{km}}{\sigma_{kmj}} \right) e^{-\left(\frac{\Delta\tau_i}{\tau}\right)^2} \tag{32}$$

where the indices correspond to the following:

ith - data point
jth - equal area cell (1654 total)
kth - magnetic component (r,θ,ϕ,F)
lth - aircraft flight or satellite orbit
mth - data type (MAGSAT, Project MAGNET)
nth - geomagnetic latitude band ($n=1$ or $n=2$)

The decay constant τ was arbitrarily chosen to be 5 years, while:

$$\Delta\tau_i = \tau_i - T_{EPOCH} \tag{33}$$

where τ_i is the time of observation in years and T_{EPOCH} is 1985.0.

Table 6 gives the overall rms errors of a particular magnetic component for each of the three separate data sets relative to the DGRF/IGRF series of WMMs. Table 7 lists the number of data points associated with each mangetic component for each of the three data sets. Table 8 lists the average number of data points per 5°x5° equal area cell for each magnetic component for each data set. Rms statistics relative to the DGRF/IGRF series of models for the Project MAGNET data set are further broken down by Project ID and flight number in table 9. Due

TABLE 6. RMS ERRORS RELATIVE TO IGRF/DGRF MODELS

	$\bar{\sigma}_x$ rms (nT)	$\bar{\sigma}_y$ rms (nT)	$\bar{\sigma}_z$ rms (nT)	$\bar{\sigma}_F$ rms (nT)
MAGSAT	14.7	12.0	13.2	12.7
Project MAGNET	101.7	107.9	105.5	96.4
DE-2	---	---	---	122.4

TABLE 7. NUMBER OF RECORDS

	N_x	N_y	N_z	N_F
MAGSAT	30473	30473	30473	30473
Project MAGNET	54656	54656	54656	54656
DE-2	---	---	---	5100

TABLE 8. AVERAGE NUMBER OF RECORDS PER CELL

	$\bar{N}_x$	$\bar{N}_y$	$\bar{N}_z$	$\bar{N}_F$
MAGSAT	18.4	18.4	18.4	18.4
Project MAGNET	33.0	33.0	33.0	33.0
DE-2	---	---	---	3.1

TABLES 9. PROJECT MAGNET FLIGHT STATISTICS RELATIVE TO IGRF/DGRF MODELS (RMS units: nT)

PROJECT	FLIGHT	YEAR	JULIAN DAY	RMS X	RMS Y	RMS Z	RMS F
A32-153	6005	1981	129	116.4	92.3	159.0	156.6
A32-153	6006	1981	133	141.4	98.4	106.1	104.6
A32-153	6007	1981	139	223.7	242.1	191.5	200.9
A32-153	6008	1981	143	88.5	121.4	138.6	137.5
A32-153	6009	1981	146	138.3	86.6	105.3	113.9
A32-153	6010	1981	149	132.5	135.3	151.6	151.5
A32-153	6011	1981	153	200.1	115.8	177.9	176.0
A32-153	6012	1981	155	107.8	233.3	107.0	106.8
A32-153	6013	1981	157	283.0	128.6	181.6	175.2
A32-153	6014	1981	159	146.4	166.2	110.6	111.3
A32-153	6015	1981	162	111.3	101.2	135.2	135.8
C32-252	1074	1982	62	60.1	51.9	49.2	73.2
C32-252	2007	1982	64	68.9	96.6	87.4	82.1
C32-252	2009	1982	67	79.4	76.6	85.1	74.0
C32-252	2011	1982	74	84.0	108.4	103.9	103.4
C32-252	2012	1982	77	95.1	74.4	65.7	94.5
C32-252	2013	1982	89	63.4	60.0	64.8	61.8
C32-252	2014	1982	96	80.5	70.8	79.8	76.8
C32-253	1077	1982	135	85.4	68.7	93.7	93.8
C32-253	1080	1982	149	86.0	121.8	58.9	66.3
C32-253	1081	1982	161	133.6	48.8	48.8	126.9
C32-253	1084	1982	171	63.0	54.8	99.1	91.1
C32-253	1085	1982	175	58.4	61.6	78.1	73.5
C32-253	1086	1982	177	164.8	103.3	162.0	185.9
C32-253	1087	1982	180	98.2	87.1	119.7	122.7
C32-253	1088	1982	182	122.5	134.2	160.7	154.8
C32-253	1091	1982	186	112.4	66.2	98.3	100.1
C32-254	4027	1982	231	86.4	91.4	64.1	70.2
C23-245	4028	1982	233	155.3	81.4	81.1	76.4
C32-254	4049	1982	236	120.9	87.9	89.2	78.1
C32-254	5022	1982	243	100.2	71.1	50.6	60.9
C32-254	5023	1982	246	87.9	74.2	67.2	60.8
C32-254	5026	1982	251	88.4	63.5	71.6	84.4
C32-254	5037	1982	260	81.1	79.5	60.3	83.0
C32-254	5030	1982	274	81.1	80.3	83.0	84.0
C32-254	5031	1982	277	131.6	46.9	90.3	81.1
C32-351	1097	1982	304	150.6	91.3	128.3	147.6
C32-351	3074	1982	305	109.4	126.3	63.6	101.4
C32-351	3075	1982	307	105.5	137.6	89.6	99.9
C32-351	403[illegible]	1982	309	103.6	57.3	79.9	96.1
C32-351	4032	1982	312	86.5	128.3	88.9	91.8
C32-351	4033	1982	314	94.9	101.6	97.9	100.0
C32-351	4034	1982	320	73.0	92.1	115.1	93.1
C32-351	4035	1982	322	59.1	144.1	64.6	66.8
C32-351	4036	1982	324	71.6	85.6	105.2	100.3
C32-351	5033	1982	327	208.2	191.1	118.5	124.3

TABLES 9. PROJECT MAGNET FLIGHT STATISTICS RELATIVE TO IGRF/DGRF MODELS (RMS units: nT) (con.)

PROJECT	FLIGHT	YEAR	JULIAN DAY	RMS X	RMS Y	RMS Z	RMS F
C32-351	4037	1982	332	64.3	75.7	69.8	69.5
C32-351	4038	1982	334	83.3	87.6	89.7	76.5
C32-351	4039	1982	337	72.9	91.8	90.8	84.5
C32-351	4040	1982	339	52.6	67.9	90.9	90.2
C32-351	4041	1982	341	146.6	104.0	81.2	135.6
C32-351	4042	1982	345	83.8	78.9	52.6	82.9
C32-351	4044	1982	350	63.0	83.2	86.0	73.5
C32-351	1098	1982	351	129.4	67.8	145.8	160.3
C32-352	1089	1983	27	64.4	65.0	81.3	78.5
C32-352	1090	1983	31	50.1	80.2	37.3	44.1
C32-352	1099	1983	34	75.6	75.2	101.3	87.3
C32-352	5045	1983	75	98.9	101.5	79.9	98.0
C32-352	5046	1983	78	89.6	80.5	81.6	80.3
C32-352	5047	1983	81	109.5	72.7	83.2	75.0
C32-352	5048	1983	84	212.6	106.5	145.5	130.5
C32-352	4045	1983	87	255.4	236.2	116.9	138.8
C32-352	4046	1983	91	39.4	76.6	56.8	45.1
C32-352	4048	1983	96	59.2	93.9	58.7	69.6
C32-352	1100	1983	99	31.8	35.3	71.1	64.3
C32-353	3076	1983	228	86.3	76.8	111.5	114.6
C32-353	3077	1983	130	64.1	191.7	94.8	76.7
C32-353	3080	1983	161	91.0	71.4	67.8	94.8
C32-353	3081	1983	166	124.0	61.9	115.2	136.6
C32-353	3082	1983	169	96.1	51.1	98.2	93.4
C32-353	3083	1983	171	59.7	121.5	76.2	67.0
C32-353	3084	1983	175	73.2	110.1	96.5	93.4
C32-353	3085	1983	179	91.6	100.1	103.9	114.5
C32-353	3086	1983	183	82.7	64.7	87.7	105.9
C32-353	3087	1983	186	44.8	100.9	64.8	58.9
C32-451	3088	1983	325	73.4	73.7	78.4	83.8
C32-451	3089	1983	327	92.5	66.1	60.9	96.1
C32-451	3090	1983	330	107.6	169.3	112.0	125.5
C32-451	5050	1983	144	93.4	81.6	138.8	134.3
C32-451	5051	1983	336	48.9	49.9	56.8	57.6
C32-451	4051	1983	340	174.0	133.1	103.2	114.6
C32-451	4052	1983	343	114.6	67.4	95.5	105.8
C32-451	4053	1983	346	109.1	130.4	109.4	107.4
C32-451	4054	1983	349	77.8	74.0	94.5	101.6
C32-352	4046	1983	91	39.4	76.6	56.8	45.1
C32-451	1103	1983	354	29.7	35.8	52.8	47.5
C32-452	1108	1984	35	103.7	86.2	110.9	54.4
C32-452	1106	1984	41	115.3	113.8	124.9	122.6
C32-452	5049	1984	45	105.9	58.8	156.2	63.5
C32-452	3091	1984	51	53.2	265.5	242.9	56.3
C32-452	5052	1984	64	120.5	194.8	111.9	97.0
C32-452	4050	1984	67	168.6	175.2	80.7	64.3
C32-452	4055	1984	73	146.1	91.9	174.5	101.3
C32-452	4057	1984	76	61.8	58.1	123.0	44.3
C32-452	4058	1984	78	86.2	68.6	127.7	55.3
C32-452	4059	1984	84	51.3	139.6	158.6	45.2
C32-452	4060	1984	88	28.8	138.5	98.0	38.3

TABLE 9. PROJECT MAGNET FLIGHT STATISTICS RELATIVE TO IGRF/DGRF MODELS (RMS units: nT) (con.)

PROJECT	FLIGHT	YEAR	JULIAN DAY	RMS X	RMS Y	RMS Z	RMS F
C32-452	4061	1984	91	76.2	62.7	93.1	90.9
C32-452	1107	1984	93	105.8	79.1	139.6	112.5
C32-453	1109	1984	137	97.5	86.3	116.8	115.4
C32-453	3092	1984	140	163.7	83.1	96.5	83.5
C32-453	3094	1984	157	80.1	99.9	119.2	86.9
C32-453	3095	1984	161	70.8	64.8	63.8	79.6
C32-453	3096	1984	164	71.5	153.6	121.6	68.7
C32-453	3097	1984	171	100.8	71.3	88.8	69.9
C32-453	3098	1984	168	138.9	149.5	115.5	81.9
C32-453	3099	1984	171	114.3	79.5	98.6	107.2
C32-453	3101	1984	176	61.4	72.5	75.3	76.2
C32-453	3100	1984	180	98.4	83.6	113.5	118.0
C32-453	3102	1984	183	78.8	69.8	101.2	101.8
C32-453	3103	1984	186	96.7	78.4	125.3	113.1
C32-453	3104	1984	190	68.7	84.4	79.0	88.2
C32-453	1110	1984	192	83.5	88.6	127.5	122.6
C32-454	1048	1984	215	135.4	111.5	165.6	165.2
C32-454	1075	1984	219	62.7	61.5	96.2	96.6
C32-454	1070	1984	221	59.2	74.2	96.3	95.8
C32-454	1121	1984	224	75.6	86.2	100.3	84.0
C32-454	1122	1984	227	69.4	71.7	88.2	70.5
C32-454	1123	1984	230	54.4	52.2	77.8	70.1
C32-454	1124	1984	237	59.7	62.5	100.3	106.8
C32-454	1117	1984	242	101.4	79.2	126.6	129.0
C32-454	1118	1984	246	44.2	78.5	66.4	57.9
C32-454	1119	1984	249	52.6	55.5	71.1	61.1
C32-454	1120	1984	252	57.9	41.8	83.9	66.1
C32-454	1111	1984	255	74.4	63.4	101.4	100.0
C32-454	1112	1984	258	93.6	91.6	113.1	111.5
C32-454	1114	1984	262	66.3	60.8	42.3	55.4
C32-454	1115	1984	272	34.8	37.4	57.2	52.3
C32-551	1126	1984	290	64.6	69.8	81.9	70.9
C32-551	2015	1984	292	117.5	134.4	44.2	141.8
C32-551	2016	1984	295	54.2	101.1	97.9	94.2
C32-551	7005	1984	298	174.7	91.3	114.3	112.2
C32-551	7006	1984	304	80.4	97.5	75.4	76.0
C32-551	7007	1984	307	218.4	186.7	96.3	96.8
C32-551	4065	1984	310	206.9	218.9	121.1	85.7
C32-551	4066	1984	313	101.5	103.3	81.6	79.7
C32-551	4067	1984	319	70.7	137.9	87.8	59.1
C32-551	4068	1984	321	198.6	160.0	107.2	86.6
C32-551	4069	1984	325	119.4	170.7	97.7	62.9
C32-551	4070	1984	329	76.6	232.9	79.9	63.3
C32-551	4071	1984	333	121.9	124.8	74.6	69.4
C32-551	4072	1984	337	91.2	109.8	104.4	93.2
C32-551	3105	1984	342	84.6	52.4	150.7	97.3
C32-551	1127	1984	345	45.9	48.7	95.5	87.6
C32-552	1125	1985	16	81.6	61.5	77.1	54.4
C32-552	1131	1985	19	87.2	105.9	85.2	54.0
C32-552	1132	1985	27	115.7	106.3	72.2	62.7
C32-552	1133	1985	30	88.6	260.8	138.9	124.5

TABLE 9. PROJECT MAGNET FLIGHT STATISTICS RELATIVE TO IGRF/DGRF MODELS (RMS units: nT) (con.)

PROJECT	FLIGHT	YEAR	JULIAN DAY	RMS X	RMS Y	RMS Z	RMS F
C32-552	2017	1985	33	58.0	136.3	49.0	65.1
C32-552	2029	1985	35	46.1	182.4	41.7	39.0
C32-552	2030	1985	37	68.9	198.5	59.2	78.5
C32-552	2031	1985	40	85.4	127.8	46.0	105.1
C32-552	2032	1985	43	62.6	137.2	104.0	111.7
C32-552	2033	1985	46	54.4	113.0	73.8	71.2
C32-552	2034	1985	49	35.3	110.4	48.6	40.4
C32-552	2022	1985	53	33.6	116.8	59.5	46.1
C32-552	2023A	1985	57	40.0	125.1	64.1	51.9
C32-552	2023	1985	61	75.3	127.6	89.7	85.4
C32-552	7009	1984	62	114.5	99.4	107.0	132.0
C32-552	7008	1985	66	73.0	103.3	75.8	73.0
C32-552	7010	1984	69	101.7	104.1	93.0	102.1
C32-552	7011	1985	71	51.4	123.0	65.5	68.5
C32-552	2036	1985	75	78.6	158.4	83.4	33.6
C32-552	1129	1985	80	209.1	201.6	127.2	51.3
C32-552	1130	1985	84	63.3	59.0	71.4	70.1
C32-553	1134	1985	114	135.9	130.2	96.9	75.0
C32-553	3106	1985	116	54.1	112.2	88.0	92.6
C32-553	3108	1985	120	57.3	112.8	74.9	72.2
C32-553	3109	1985	123	62.7	112.7	55.0	56.2
C32-553	3110	1985	126	59.2	99.9	59.2	56.4
C32-553	3107	1985	129	50.1	131.1	52.2	55.8
C32-553	3111	1985	136	101.9	63.2	157.6	72.9
C32-553	3112	1985	140	60.6	79.0	145.9	61.2
C32-553	3113	1985	144	93.0	67.1	82.7	89.7
C32-553	3114	1985	148	61.0	158.4	80.6	61.3
C32-553	3116	1985	154	81.2	75.5	120.8	61.2
C32-553	3117	1985	157	132.3	82.7	120.9	75.1
C32-553	3118	1985	160	129.8	89.1	145.6	106.9
C32-553	3119	1985	169	223.0	145.9	114.4	111.3
C32-553	3121	1985	171	232.4	111.7	127.1	132.9
C32-553	3122	1985	174	134.8	193.1	130.4	122.9
C32-554	1135	1985	196	105.3	123.5	137.1	131.2
C32-554	1137	1985	210	62.2	58.0	69.9	71.6
C32-554	1136	1985	202	60.8	89.1	85.9	85.3
C32-554	1138	1985	213	109.1	115.5	111.9	109.7
C32-554	1139	1985	217	68.0	78.5	85.3	86.3
C32-554	1140	1985	220	155.7	109.2	126.9	134.0
C32-554	6016	1985	230	151.3	158.4	165.6	174.5
C32-554	1144	1985	244	147.6	116.2	186.4	181.8
C32-554	1141	1985	249	96.4	83.0	91.[illegible]	92.6
C32-554	1142	1985	250	155.0	128.9	151.0	151.9
C32-554	6017	1985	252	182.3	94.8	136.2	117.9
C32-651	1143	1985	281	65.6	101.2	88.1	72.2
C32-651	4074	1985	285	32.3	148.1	83.1	36.0
C32-651	4075	1985	290	38.0	225.2	85.0	52.8
C32-651	3125	1985	301	72.0	236.2	95.8	70.4
C32-651	3126	1985	305	61.4	110.8	80.4	62.6
C32-651	5053	1985	314	77.3	178.2	105.1	98.0
C32-651	4077	1985	317	97.0	202.1	114.7	112.4

TABLE 9. PROJECT MAGNET FLIGHT STATISTICS RELATIVE TO IGRF/DGRF MODELS (RMS units: nT) (con.)

PROJECT	FLIGHT	YEAR	JULIAN DAY	RMS X	RMS Y	RMS Z	RMS F
C32-651	5054	1985	321	83.8	129.6	166.1	145.2
C32-651	5055	1985	324	50.6	68.9	74.4	74.2
C32-651	4078	1985	327	78.6	133.7	68.8	68.6
C32-651	4079	1985	331	78.6	152.5	82.6	74.5
C32-651	4080	1985	334	151.6	247.3	182.1	166.7
C32-651	4081	1985	340	89.5	216.9	119.7	89.5
C32-651	4083	1985	343	78.5	96.0	136.6	143.6
C32-651	4084	1985	345	64.8	77.3	75.3	60.7
C32-652	1128	1986	27	52.7	53.2	47.8	53.1
C32-652	2019	1986	32	62.2	54.5	95.4	78.1
C32-652	5059A	1986	36	49.6	39.4	88.6	63.5
C32-652	5058	1986	40	104.6	42.9	137.4	67.5
C32-652	5057	1986	42	84.3	58.1	154.9	92.3
C32-652	5067	1986	47	55.3	61.7	122.5	102.3
C32-652	5068	1986	51	65.3	61.6	127.9	102.5
C32-652	5056	1986	53	99.4	52.0	128.4	86.7
C32-652	5059B	1986	65	63.7	58.7	116.9	61.4
C32-652	5059C	1986	71	54.5	56.6	70.1	64.3
C32-652	5059D	1986	77	44.2	42.8	58.7	41.9
C32-652	5060	1986	79	45.0	71.0	69.4	49.8
C32-652	5061	1986	81	37.0	72.0	94.0	35.8
C32-652	5062	1986	85	54.2	70.0	78.4	54.2
C32-652	5063	1986	88	100.8	74.4	150.5	139.5
C32-652	5065	1986	95	102.7	75.0	122.6	122.2
C32-652	4085	1986	98	57.0	70.3	103.1	95.9
C32-652	3123	1986	101	56.3	54.8	65.6	65.2
C32-652	3124	1986	104	51.9	99.5	82.4	82.6
C32-754	3147	1987	261	135.5	116.5	90.1	98.6
C32-751	3142	1986	297	75.0	72.6	71.5	74.4
C32-751	3130	1986	327	85.1	52.9	83.4	77.5
C32-751	3131	1986	329	107.6	51.1	81.1	103.2
C32-751	3132	1986	334	89.2	50.9	95.7	85.8
C32-751	3133	1986	337	77.2	55.6	71.5	71.6
C32-751	3140	1986	343	69.1	72.8	63.6	60.8
C32-751	3134	1986	345	55.3	58.7	66.1	53.7
C32-751	3141	1986	347	40.7	48.9	64.4	51.4
C32-751	3135	1986	350	66.6	123.2	143.7	52.2
C32-751	3136	1986	353	44.1	70.3	61.1	39.8
C32-751	3138	1986	354	53.4	51.6	55.9	63.5
C32-753	1154	1987	108	107.4	101.8	140.2	138.1
C32-753	6019	1987	147	100.2	125.5	130.4	128.4
C32-753	1164	1987	181	128.8	120.9	135.7	136.7
C32-753	1160	1987	154	90.1	74.1	117.5	98.5
C32-753	1161	1987	156	31.1	76.9	15.7	21.4
C32-754	1159	1987	203	69.9	52.8	71.6	63.2
C32-754	3143	1987	206	92.5	59.7	80.2	94.0
C32-754	3144	1987	212	74.6	52.2	78.7	79.4
C32-754	4098	1987	216	67.6	135.7	97.0	65.1
C32-754	3145A	1987	231	32.8	200.2	100.4	36.8
C32-552	1133	1985	30	88.6	260.8	138.9	124.5
C32-754	5069	1987	233	83.8	181.5	85.2	88.6

TABLE 9. PROJECT MAGNET FLIGHT STATISTICS RELATIVE TO IGRF/DGRF MODELS (RMS units: nT) (con.)

PROJECT	FLIGHT	YEAR	JULIAN DAY	RMS X	RMS Y	RMS Z	RMS F
C32-754	5071	1987	251	43.4	54.7	128.0	62.5
C32-754	3145	1987	245	63.3	109.9	78.5	59.7
C32-754	4100	1987	251	64.6	70.3	134.2	61.8
C32-754	3146	1987	246	116.9	81.8	114.4	90.3
C32-851	3148	1987	291	98.6	100.0	103.0	105.9
C32-851	3149	1987	295	61.9	104.6	96.1	80.9
C32-851	3150	1987	299	103.3	88.3	104.1	111.4
C32-851	3152	1987	306	130.9	97.7	116.4	108.3
C32-851	3154	1987	312	69.6	131.4	77.5	69.0
C32-851	3155	1987	316	76.5	60.7	68.1	74.5
C32-851	3156	1987	320	66.1	76.6	81.6	66.7
C32-851	3157	1987	325	81.5	159.6	112.9	88.9
C32-851	3158	1987	29	146.3	87.1	94.3	100.8
C32-851	3159	1987	32	93.8	78.8	110.4	55.5
C32-851	3160	1987	335	63.7	68.6	75.5	73.9
C32-851	3161	1987	348	78.8	45.3	78.0	60.5
C32-852	1167	1988	20	85.2	58.2	101.3	71.7
C32-852	4101	1988	24	42.1	32.6	84.9	33.3
C32-852	4102	1988	27	45.5	67.9	61.1	47.8
C32-852	4103	1988	30	51.7	59.1	68.3	44.3
C32-852	4104	1988	34	103.8	40.7	97.6	57.6
C32-852	4106	1988	39	78.9	70.3	80.6	77.7
C32-852	4107	1988	41	53.9	63.7	80.4	40.2
C32-852	4111	1988	43	84.9	66.2	65.7	70.2
C32-852	4108	1988	49	83.4	56.2	93.5	81.4
C32-852	3162	1988	50	71.9	54.9	82.7	74.2
C32-852	3163	1988	56	58.3	74.1	116.4	67.6
C32-852	3167	1988	59	78.4	131.6	105.8	71.4
C32-852	4110	1988	63	49.2	59.8	94.5	56.6
C32-852	4105	1988	62	71.8	72.3	67.4	63.2
C32-852	3164	1988	77	87.9	49.7	113.9	59.9
C32-952	1177	1989	77	118.1	98.2	139.4	147.2
C32-952	1178	1989	79	115.5	88.6	136.5	147.5
C32-952	1179	1989	81	111.8	79.2	119.8	133.8
C32-952	1180	1989	83	138.4	95.6	122.8	149.6
C32-553	3115	1985	151	122.6	142.2	113.2	88.0
C32-651	3123A	1985	292	53.2	162.1	88.3	63.0
C32-651	3124A	1985	294	56.3	188.8	86.5	64.0
C32-352	5044	1983	69	97.6	88.2	92.9	67.7
C32-853	4113	1988	153	80.3	89.1	114.8	87.9
C32-453	4063	1984	150	71.3	60.2	108.6	78.8
C32-453	4064	1984	152	55.7	53.8	87.6	58.4
C32-951	4122	1988	283	100.9	135.6	151.5	160.6
C32-951	4123	1988	291	96.6	67.8	106.5	92.8
C32-951	4124	1988	295	77.4	66.2	91.0	80.2
C32-951	4125	1988	295	130.2	82.5	75.5	122.6
C32-951	4126	1988	303	103.0	129.4	114.6	92.5
C32-951	4127	1988	310	57.1	77.4	82.7	73.5
C32-951	4120	1988	297	107.7	69.3	80.0	91.0
C32-951	4135	1988	345	71.1	39.9	79.4	48.7
C32-951	5084	1988	324	78.8	44.6	108.0	81.1

TABLE 9. PROJECT MAGNET FLIGHT STATISTICS RELATIVE TO IGRF/DGRF MODELS (RMS units: nT) (con.)

PROJECT	FLIGHT	YEAR	JULIAN DAY	RMS X	RMS Y	RMS Z	RMS F
C32-253	1079	1982	145	59.4	53.4	80.5	75.1
C32-853	5073	1988	117	117.5	93.1	261.8	263.4
C32-853	5081	1988	119	73.9	154.1	190.2	182.8
C32-853	5082	1988	122	114.2	110.7	209.3	182.8
C32-853	1168	1988	105	45.9	99.5	66.4	58.6
C32-853	1169	1988	174	82.2	57.7	106.3	58.0
C32-853	5076B	1988	131	72.2	98.1	86.3	84.0
C32-853	5083	1988	124	133.5	60.2	257.0	189.4
C32-853	4114	1988	164	61.5	76.7	85.1	74.5
C32-853	4115	1988	168	108.9	96.5	99.6	87.3
C32-853	4116	1988	171	104.9	66.0	91.4	88.8
C32-951	1171	1988	277	74.8	55.5	79.4	78.2
C32-951	3177	1988	307	62.5	79.5	96.4	87.1
C32-951	4119	1988	281	70.3	71.7	75.5	63.4
C32-951	4121	1988	299	113.5	117.9	195.2	215.4
C32-951	4128	1988	314	73.2	103.4	85.3	84.8
C32-951	4129	1988	318	82.6	81.7	140.2	135.7
C32-951	4130	1988	321	121.6	97.9	107.2	112.2
C32-951	4131	1988	328	73.1	90.9	141.5	126.7
C32-951	4132	1988	331	52.1	89.6	140.1	109.6
C32-951	4133	1988	333	70.6	70.4	66.9	68.8
C32-954	1184	1989	207	104.5	194.1	101.5	109.3
C32-954	1186	1989	212	106.9	171.0	99.2	94.0
C32-954	1188	1989	218	149.6	111.6	94.7	83.0
C32-954	1189	1989	223	99.8	136.8	114.4	111.8
C32-954	1190	1989	228	218.5	160.4	166.2	118.5
C32-954	1196	1989	270	99.7	72.6	79.6	72.7
C32-954	1197	1989	229	173.3	112.3	129.4	86.6
C32-954	1198	1989	234	266.8	79.3	102.3	83.3
C32-954	1199	1989	244	108.4	72.5	66.0	68.9
C32-954	4139	1989	255	102.5	116.5	93.2	78.1
C32-954	1195	1989	267	52.4	119.1	104.3	89.4
C32-954	2057	1989	263	81.3	40.7	107.8	95.3
C32-954	2052	1989	247	103.0	83.9	161.4	173.7
C32-954	2055	1989	258	77.9	68.3	88.2	93.2
C32-954	2056	1989	261	55.2	83.2	173.0	131.6
C32-954	7012	1989	252	99.8	64.4	93.9	45.3

to the uniformity of satellite data, the orbit-by-orbit statistics for MAGSAT and DE-2 data were taken to be the same as for each entire data set for each magnetic component. Note that data occupying cells for which there were fewer than 10 points were discarded due to the presumed unreliability of their cell statistics.

Now, the double summation expression over degree n and order m for $B_r(r,\theta,\phi)$, $B_\theta(r,\theta,\phi)$ and $B_\phi(r,\theta,\phi)$ can be converted to single summation expressions over the coefficient number l which ranges from 1 to 168. Then, we may write:

$$B_r(r,\theta,\phi) = \sum_{l=1}^{168} C_l Q_{rl}(r,\theta,\phi) \tag{34a}$$

$$B_\theta(r,\theta,\phi) = \sum_{l=1}^{168} C_l Q_{\theta l}(r,\theta,\phi) \tag{34b}$$

$$B_\phi(r,\theta,\phi) = \sum_{l=1}^{168} C_l Q_{\phi l}(r,\theta,\phi) \tag{34c}$$

$$B_F(r,\theta,\phi) = \sum_{l=1}^{168} C_l Q_{Fl}(r,\theta,\phi) \tag{34d}$$

where the set of coefficients $\{C_l\}_{l=1}^{168}$ are the Gauss coefficients g_{nm} and h_{nm} arbitrarily arranged so that:

$$C_l = \begin{cases} g_{nm}; & l(n,m) = n(n+1)/2 + m \\ h_{nm}; & l(n,m) = n(n-1)/2 + m + 90 \end{cases} \tag{35}$$

This ordering then requires:

$$Q_{rl}(r,\theta,\phi) = \begin{cases} (n+1)\left(\dfrac{R_E}{r}\right)^{n+2} \cos m\phi P_n^m(\theta) & ; \quad l(n,m) = n(n+1)/2 + m \\ (n+1)\left(\dfrac{R_E}{r}\right)^{n+2} \sin m\phi P_n^m(\theta) & ; \quad l(n,m) = n(n-1)/2 + m + 90 \end{cases} \tag{36a}$$

$$Q_{\theta l}(r,\theta,\phi) = \begin{cases} -\left(\dfrac{R_E}{r}\right)^{n+2} \cos m\phi \dfrac{dP_n^m(\theta)}{d\theta} & ; \quad l(n,m) = n(n+1)/2 + m \\ -\left(\dfrac{R_E}{r}\right)^{n+2} \sin m\phi \dfrac{dP_n^m(\theta)}{d\theta} & ; \quad l(n,m) = n(n-1)/2 + m + 90 \end{cases} \tag{36b}$$

$$Q_{\phi l}(r,\theta,\phi) = \begin{cases} m\left(\dfrac{R_E}{r}\right)^{n+2} \sin m\phi P_n^m(\theta)/\sin\theta & ; \quad l(n,m) = n(n+1)/2 + m \\ -m\left(\dfrac{R_E}{r}\right)^{n+2} \cos m\phi P_n^m(\theta)/\sin\theta & ; \quad l(n,m) = n(n-1)/2 + m + 90 \end{cases} \tag{36c}$$

$$Q_{Fl} = \frac{1}{B_F(r,\theta,\phi)}\{B_r(r,\theta,\phi)Q_{rl}(r,\theta,\phi) + B_\theta(r,\theta,\phi)Q_{\theta l}(r,\theta,\phi) + B_\phi(r,\theta,\phi)Q_{\phi l}(r,\theta,\phi)\} \tag{36d}$$

These expressions are the most useful forms in which the spherical harmonic equations for the magnetic field components can be cast for a least-squares problem.

Minimization of the chi-square function then requires that

$$\delta\chi^2 = \sum_{j=1}^{168} \frac{\partial\chi^2}{\partial C_j}\,\delta C_j \tag{37}$$

be a minimum, where the symbol δ means variation. This in turn requires:

$$\frac{\partial\chi^2}{\partial C_j} = 0 \qquad j = 1,\ldots,168 \tag{38}$$

Therefore, we must have:

$$\frac{\partial\chi_r^2}{\partial C_j} + \frac{\partial\chi_\theta^2}{\partial C_j} + \frac{\partial\chi_\phi^2}{\partial C_j} + \frac{\partial\chi_F^2}{\partial C_j} = 0 \qquad j = 1,\ldots,168 \tag{39}$$

which is a nonlinear system of 168 equations for the 168 unknown coefficient set $\{C_l\}_{l=1}^{168}$. This system of equations is nonlinear since χ^2 depends on B_F which depends nonlinearly on the coefficients through the expression:

$$B_F(r,\theta,\phi) = \sqrt{B_r^2(r,\theta,\phi) + B_\theta^2(r,\theta,\phi) + B_\phi^2(r,\theta,\phi)} \tag{40}$$

where, B_r, B_θ, and B_ϕ all depend linearly on the coefficients.

Consequently, after noting that:

$$\frac{\partial\chi_r^2}{\partial C_j} = \sum_{l=1}^{168} C_l \sum_{i=1}^{I_r} w_{ri} Q_{rl}(r_i,\theta_i,\phi_i) Q_{rj}(r_i,\theta_i,\phi_i) - \sum_{i=1}^{I_r} w_{ri} b_{ri} Q_{rj}(r_i,\theta_i,\phi_i) \tag{41a}$$

$$\frac{\partial \chi_\theta^2}{\partial C_j} = \sum_{l=1}^{168} C_l \sum_{i=1}^{I_\theta} w_{\theta i} Q_{\theta l}(r_i,\theta_i,\phi_i) Q_{\theta j}(r_i,\theta_i,\phi_i) - \sum_{i=1}^{I_\theta} w_{\theta i} b_{\theta i} Q_{\theta_j}(r_i,\theta_i,\phi_i) \qquad (41b)$$

$$\frac{\partial \chi_\phi^2}{\partial C_j} = \sum_{l=1}^{168} C_l \sum_{i=1}^{I_\phi} w_{\phi i} Q_{\phi l}(r_i,\theta_i,\phi_i) Q_{\phi j}(r_i,\theta_i,\phi_i) - \sum_{i=1}^{I_\phi} w_{\phi i} b_{\phi i} Q_{\phi j}(r_i,\theta_i,\phi_i) \qquad (41c)$$

$$\frac{\partial \chi_F^2}{\partial C_j} = \sum_{l=1}^{168} C_l \sum_{i=1}^{I_F} w_{F_i} \{ Q_{rl}(r_i,\theta_i,\phi_i) Q_{rj}(r_i,\theta_i,\phi_i) + Q_{\theta l}(r_i,\theta_i,\phi_i) Q_{\theta j}(r_i,\theta_i,\phi_i) + \qquad (41d)$$

$$Q_{\phi l}(r_i,\theta_i,\phi_i) Q_{\phi j}(r_i,\theta_i,\phi_i)\} - \sum_{i=1}^{I_F} w_{F_i} b_{F_i} Q_{F_j}$$

we have:

$$\sum_{l=1}^{168} C_l Q_{lj} = \Re_j \qquad j = 1,\ldots,168 \qquad (42)$$

where:

$$Q_{lj} = \sum_{i=1}^{I_r} w_{ri} Q_{rl}(r_i,\theta_i,\phi_i) Q_{rj}(r_i,\theta_i,\phi_i) + \sum_{i=1}^{I_\theta} w_{\theta i} Q_{\theta l}(r_i,\theta_i,\phi_i) Q_{\theta j}(r_i,\theta_i,\phi_i) + \qquad (43)$$

$$\sum_{i=1}^{I_\phi} w_{\phi i} Q_{\phi l}(r_i,\theta_i,\phi_i) Q_{\phi j}(r_i,\theta_i,\phi_i) + \sum_{i=1}^{I_F} w_{Fi} \{ Q_{rl}(r_i,\theta_i,\phi_i) Q_{rj}(r_i,\theta_i,\phi_i) +$$

$$Q_{\theta l}(r_i,\theta_i,\phi_i) Q_{\theta j}(r_i,\theta_i,\phi_i) + Q_{\phi l}(r_i,\theta_i,\phi_i) Q_{\phi j}(r_i,\theta_i,\phi_i)\}$$

and

$$\Re_j = \sum_{i=1}^{I_r} w_{ri} b_{ri} Q_{rj}(r_i,\theta_i,\phi_i) + \sum_{i=1}^{I_\theta} w_{\theta i} b_{\theta i} Q_{\theta j}(r_i,\theta_i,\phi_i) + \qquad (44)$$

$$\sum_{i=1}^{I_\phi} w_{\phi i} b_{\phi i} Q_{\phi j}(r_i,\theta_i,\phi_i) + \sum_{i=1}^{I_F} w_{Fi} b_{Fi} Q_{Fi}(r_i,\theta_i,\phi_i)$$

This system of 168 equations can be written in matrix form as:

$$CQ = \Re \qquad (45)$$

which has the inverse:

$$C = Q^{-1}\Re \qquad (46)$$

This is **not** the solution to the problem, however, since the right-hand side of this equation also depends on the unknown coefficients C_l. That is, each element, $\Re_l$, of the vector $\Re$ depends on $Q_F(r,\theta,\phi)$, which depends on the unknown coefficients C_l in a very nonlinear way.

In order to solve this system of equations, we must iterate. If ρ is the iteration index, then we can let:

$$C_l^{(\rho)} = C_l^{(\rho-1)} + \delta C_l \qquad (47)$$

Then, in matrix form, we choose the following iteration scheme:

$$C^{(\rho)} \equiv Q^{-1}\Re^{(\rho-1)} \qquad \rho = 1,2,\ldots\rho_{max} \qquad (48)$$

The maximum number of iterations ρ_{max} is determined by requiring that:

$$\sum_{l=1}^{168} \delta C_l \le 1 \quad nanotesla \quad at \quad \rho = \rho_{max} \qquad (49)$$

This condition must be tested after each iteration until it is satisfied.

The rate of convergence of the algorithm depends strongly on the amount of noise (i.e., crustal influences, etc.) in the data. Aeromagnetic data have a great deal of crustal noise in them. Filtering the data to remove short wavelength (≤ 700 km) features from the data can improve the convergence rate by an order of magnitude. However, it has been shown that one-dimensional filters along the survey track leave short wavelength biases in the cross-track direction which adversely affect the final model. Consequently, no filtering (except for a very short wavelength (≤ 7 km) low-pass filter) was done on the aeromagnetic data. The number of iterations required for the model was $\rho_{max} = 14$.

In order to implement the algorithm it is necessary to have an initial guess solution $C^{(0)}$ that is as close as possible to the actual solution. The a priori model coefficients used were the existing WC-85 model coefficients (Quinn, Kerridge, and Barraclough, 1986).

Notice that in this iteration scheme, the Q matrix, which has (168 x 168) elements (as does its inverse Q^{-1}), needs to be computed only once since it does **not** depend on the coefficients C_l. Note, too, that Q is a symmetric matrix so that only half of the elements in Q actually need to be computed.

SECTION 3. DISCUSSION

3.0 Modeling Results

An indication of the erratic nature of the geomagnetic field is provided by the wandering of the North and South Geomagnetic Poles. The pole movements since 1945 are illustrated in charts 5 and 6 which are based on the International Geomagnetic Reference Field (IGRF) models, WC-85 (revised) and WMM-90. The pole movements illustrate a poorly understood phenomena known as the geomagnetic jerk which occurred around 1970. The South Magnetic Pole movement in particular illustrates a sudden change in direction at about that time. These jerks occur only a few times per century and are thought to be due to a sudden release of magnetic energy built up from the electromagnetic coupling between the top of the fluid core and the lower mantle, both of which have substantial electrical conductivities. The numerical pole positions at one-year intervals for both poles are listed in table 10.

It should be noted that roughly 90 percent of the Earth's magnetic field is contained in the degree 1 spherical harmonic coefficients: g_1^0, g_1^1, and h_1^1. These three coefficients characterize the Earth's magnetic dipole field and form the basis of the geomagnetic coordinate system, which for the 1990 epoch is illustrated in chart 7. The axis of the geomagnetic coordinate system pierces the Earth's surface at the Earth's magnetic dipoles, which are different from the dip poles. The location of the dipole poles is determined when the horizontal (H) component of the dipole field, computed from just the degree $n=1$ coefficients, is equal to zero. The dip poles on the other hand are determined when the horizontal (H) component of the field is computed using all 168 coefficients of the full-degree $n=12$ model is equal to zero. For the WMM-90 model at 1990.0, the North magnetic dipole pole position is located at +79.35 degrees latitude and -71.10 degrees longitude, while the South magnetic dipole pole position is located at -79.35 degrees latitude and +108.86 degrees longitude. The displacement vector for the eccentric dipole for 1990.0 in the usual Earth-fixed spherical coordinate system (i.e., Z-axis is the rotation axis, X-axis points to the prime meridian and the Y-axis is orthogonal to the other two, thereby creating a right-handed system) is 512 km radially outward from the Earth's center, with a colatitude 21.12 degrees and a longitude of 145.70 degrees.

A grid of main field and annual change values of the Earth's magnetic field derived from WMM-90 are tabulated in table 11 for seven basic magnetic field components (X,Y,Z,H,F,D,I). Contours of five of these components (Z,H,F,D,I) for the main field are illustrated in charts 8 through 12. Contours of the annual change of these five components are illustrated in charts 13 through 17. These charts were plotted on a corrected Mercator projection.

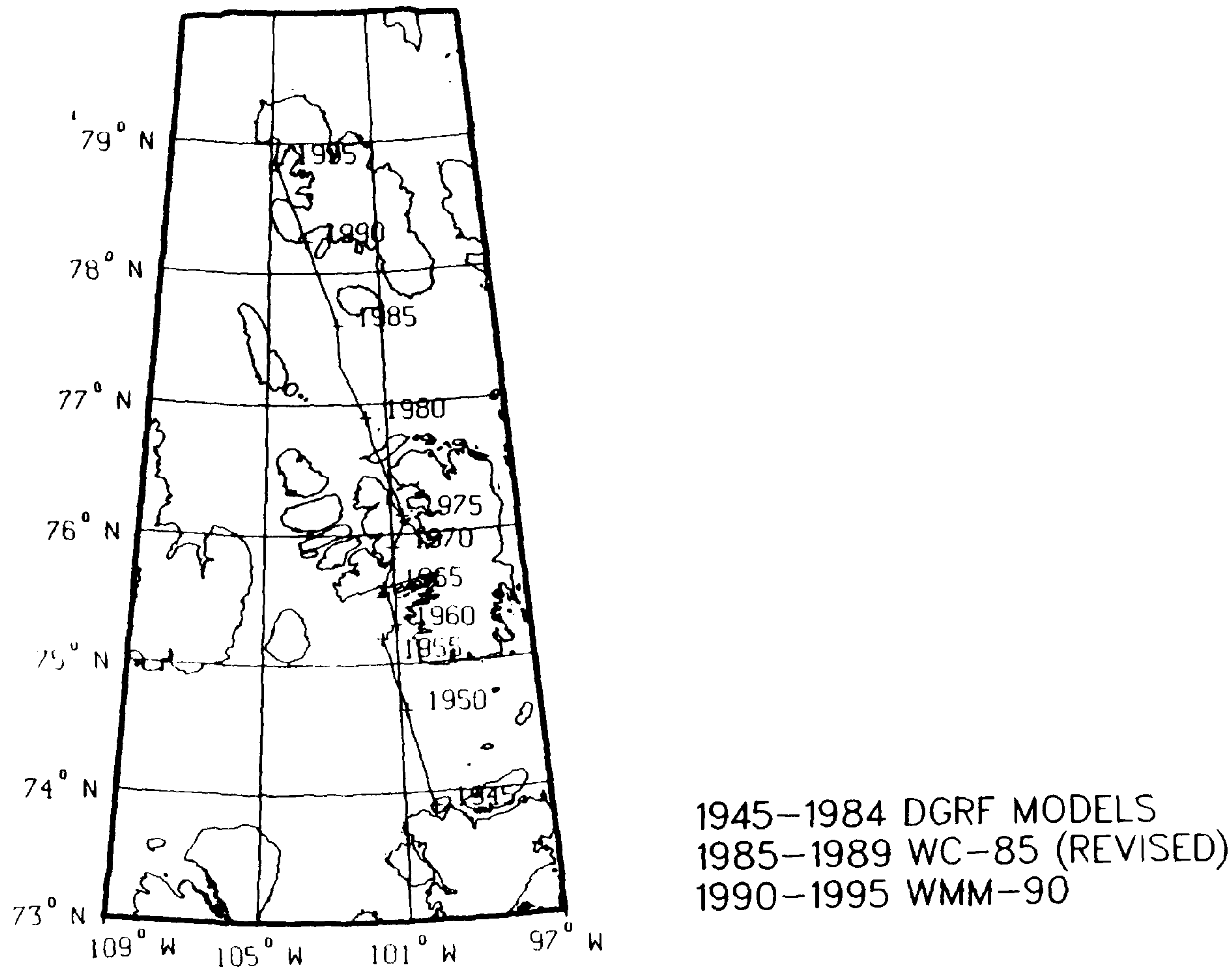


CHART 5. NORTH MAGNETIC POLE MOVEMENT

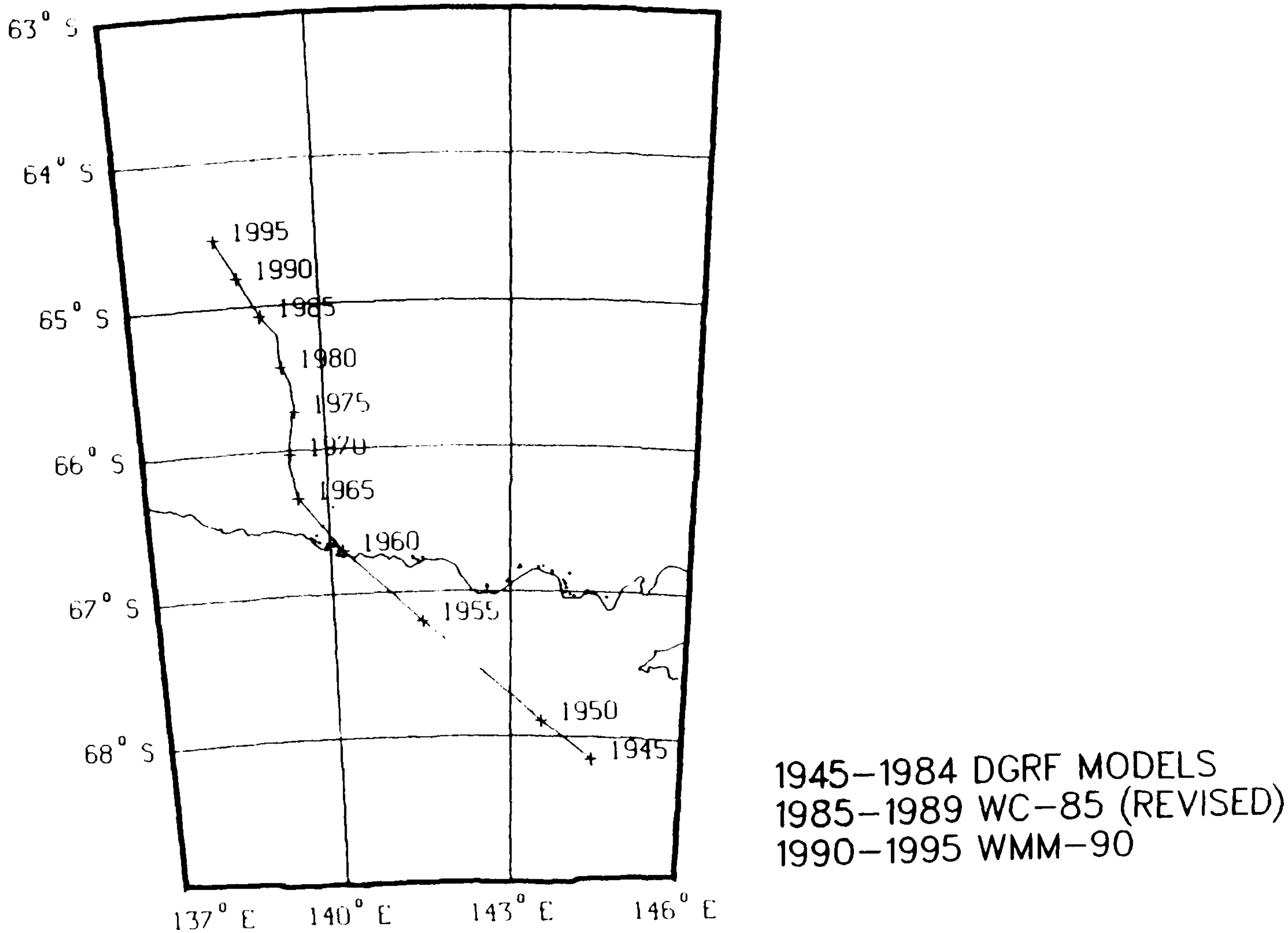


CHART 6. SOUTH MAGNETIC POLE MOVEMENT

TABLE 10. DIP POLE POSITIONS

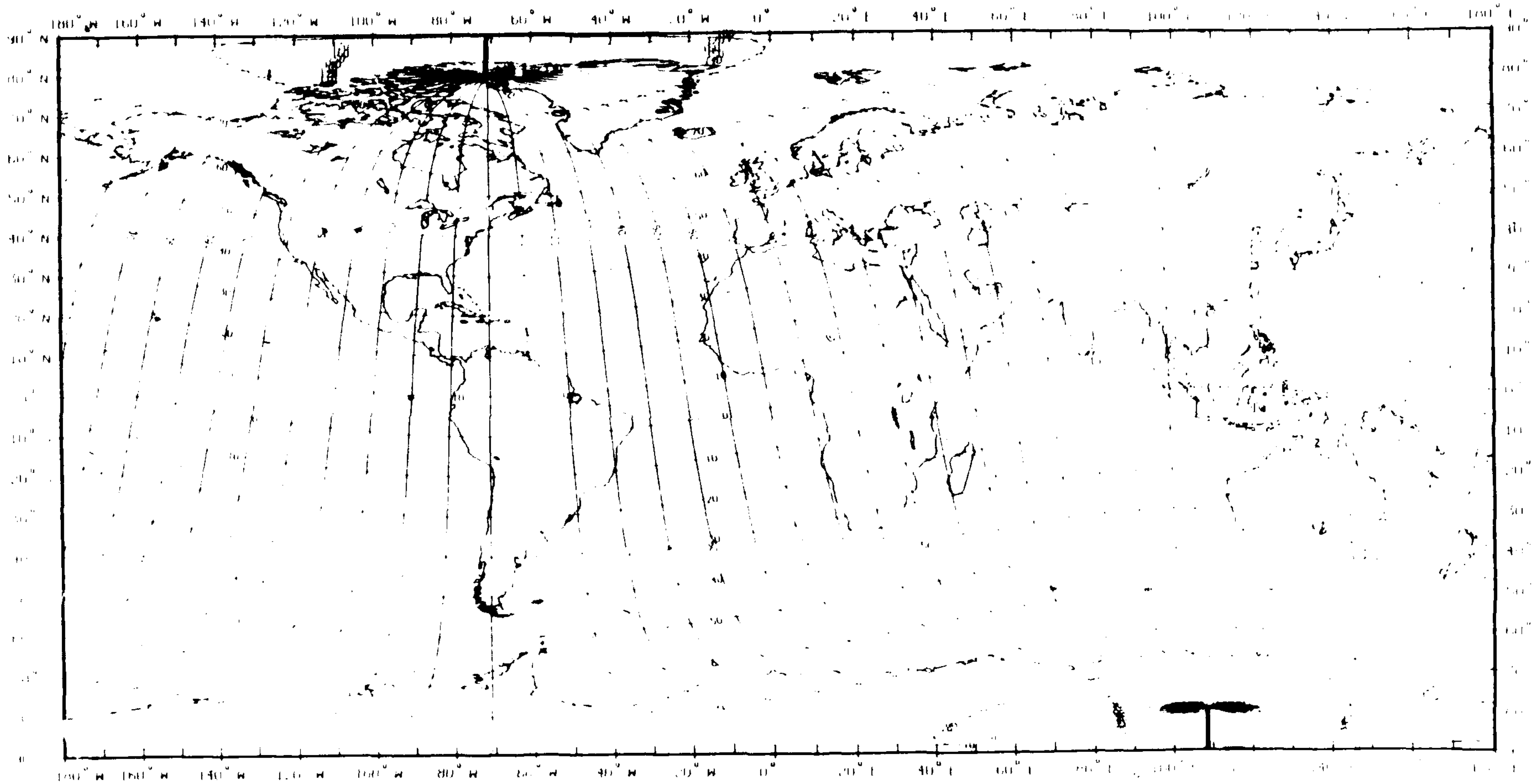
	Year	North Pole Latitude (degrees)	North Pole Longitude (degrees)	South Pole Latitude (degrees)	South Pole Longitude (degrees)
1	1945.000	73.90	-100.20	-68.15	144.42
2	1946.000	74.05	-100.35	-68.10	144.25
3	1947.000	74.20	-100.45	-68.05	144.08
4	1948.000	74.35	-100.60	-68.00	143.91
5	1949.000	74.50	-100.75	-67.94	143.71
6	1950.000	74.65	-100.85	-67.89	143.53
7	1951.000	74.75	-100.95	-67.75	143.12
8	1952.000	74.85	-101.10	-67.62	142.72
9	1953.000	74.95	-101.20	-67.48	142.31
10	1954.000	75.05	-101.25	-67.34	141.90
11	1955.000	75.20	-101.45	-67.20	141.50
12	1956.000	75.20	-101.35	-67.10	141.24
13	1957.000	75.25	-101.30	-67.00	140.99
14	1958.000	75.25	-101.20	-66.91	140.75
15	1959.000	75.30	-101.15	-66.81	140.50
16	1960.000	75.30	-101.05	-66.70	140.21
17	1961.000	75.35	-101.10	-66.63	140.08
18	1962.000	75.45	-101.15	-66.55	139.93
19	1963.000	75.50	-101.25	-66.48	139.79
20	1964.000	75.55	-101.25	-66.41	139.67
21	1965.000	75.60	-101.35	-66.33	139.51
22	1966.000	75.65	-101.25	-66.27	139.48
23	1967.000	75.70	-101.20	-66.21	139.44
24	1968.000	75.75	-101.10	-66.15	139.41
25	1969.000	75.80	-101.05	-66.09	139.38
26	1970.000	75.90	-101.00	-66.03	139.40
27	1971.000	75.95	-100.90	-65.96	139.40
28	1972.000	76.00	-100.80	-65.90	139.43
29	1973.000	76.05	-100.70	-65.84	139.46
30	1974.000	76.10	-100.60	-65.77	139.46
31	1975.000	76.15	-100.65	-65.74	139.51
32	1976.000	76.30	-100.85	-65.69	139.51
33	1977.000	76.40	-101.05	-65.63	139.49
34	1978.000	76.55	-101.25	-65.58	139.49
35	1979.000	75.65	-101.45	-65.52	139.46
36	1980.000	76.90	-101.70	-65.43	139.35
37	1981.000	77.00	-101.90	-65.37	139.33
38	1982.000	77.10	-102.10	-65.31	139.32
39	1983.000	77.20	-102.30	-65.26	139.33
40	1984.000	77.30	-102.55	-65.20	139.31
41	1985.000	77.60	-102.60	-65.07	139.06
42	1986.000	77.75	-102.80	-65.02	139.00
43	1987.000	77.85	-103.00	-64.96	138.93
44	1988.000	78.00	-103.25	-64.91	138.87
45	1989.000	78.10	-103.40	-64.86	138.81
46	1990.000	78.25	-103.70	-64.80	138.74
47	1991.000	78.35	-103.85	-64.75	138.69
48	1992.000	78.50	-104.15	-64.69	139.61
49	1993.000	78.60	-104.35	-64.64	138.56
50	1994.000	78.70	-104.55	-64.58	138.48
51	1995.000	78.85	-104.80	-64.53	138.43

Contours of these same five main field magnetic components plus grid variation in the north polar region are given in charts 18 through 23, while contours of their secular variations are given in charts 24 through 29. Similarly, for the south polar region, the main field contours are given in charts 30 through 35, while the corresponding secular variations are given in charts 36 through 41. These polar charts were plotted on a polar stereographic projection. Both the Mercator and polar stereographic charts were generated with respect to the 1984 World Geodetic System (WGS-84) ellipsoid.

3.1 Final Comments

The Polar Orbiting Geomagnetic Survey (POGS) satellite was launched in April of 1990, too late to be used in the 1990 epoch model. WMM-90, having been derived from data sets independent of POGS, will be a useful tool for evaluating POGS data and vice versa. Initial quantitative comparisons between WMM-90 and the POGS data indicate excellent agreement between the two. The POGS data will be used to fabricate the 1995 epoch model. Furthermore, if the satellite remains operational for its maximum expected lifetime of three years, it will for the first time be possible to generate a secular variation model to the same degree and order as the main field (i.e., $N = M = 12$).

Looking toward the end of this century and beyond, efforts have been made to secure data for modeling purposes via the Defense Meteorological Satellite Program (DMSP) platform. Efforts are underway to secure scalar data from a boom-mounted POGS-type magnetometer on the S-15 DMSP satellite. This data will support the Epoch 2000 WMM. Further out, efforts are being made to secure full vector magnetic capability from DMSP Block 6 satellites that will operate during the first quarter of the next century.



U. S. NAVAL OCEANOGRAPHIC OFFICE

CHART 7. GEOMAGNETIC COORDINATES

TABLE 11. WMM-90 MAIN FIELD AND ANNUAL CHANGE GRID VALUES

NORTH COMPONENT (X) WMM-90

E. LONG / LAT	0	5	10	15	20	25	30	35	40	45	50	55	E. LONG / LAT
90	1859 -6.5	1955 -7.8	2012 -9.1	2076 -10.2	2124 -11.3	2156 -12.3	2172 -13.2	2171 -14.0	2153 -14.7	2120 -15.3	2070 -15.8	2004 -16.1	90
85	4451 -12.1	4555 -13.9	4614 -15.5	4627 -16.9	4595 -18.1	4521 -19.1	4406 -19.9	4255 -20.[illegible]	4073 -20.9	3863 -21.1	3631 -21.2	3384 -21.0	85
80	6773 -13.6	6857 -15.8	6919 -17.7	6912 -19.4	6845 -20.9	6719 -22.0	6537 -22.9	6304 -23.6	6027 -24.0	5712 -24.2	5366 -24.3	5003 -24.1	80
75	8799 -11.6	8934 -14.2	8999 -16.4	8996 -18.3	8926 -19.9	8793 -21.2	8600 -22.2	8351 -23.0	8051 -23.6	7708 -24.0	7329 -24.3	6923 -24.5	75
70	10791 -7.6	10918 -10.5	10980 -12.9	10980 -15.0	10921 -16.7	10806 -18.0	10639 -19.0	10621 -19.8	10157 -20.5	9850 -21.0	9506 -21.5	9133 -22.0	70
65	12840 -3.1	12940 -6.3	12984 -9.0	12978 -11.2	12928 -13.0	12838 -14.3	12710 -15.2	12548 -15.9	12351 -16.3	12122 -16.7	11862 -17.0	11576 -17.5	65
60	15016 1.3	15098 -2.4	15112 -5.6	15089 -8.1	15038 -10.1	14965 -11.5	14874 -12.3	14768 -12.8	14647 -12.6	14510 -12.4	14357 -12.5	14190 -12.2	60
55	17413 5.4	17439 1.1	17422 -2.8	17378 -6.0	17319 -8.4	17253 -10.0	17188 -10.7	17126 -10.7	17070 -10.2	17018 -9.4	16972 -8.4	16929 -7.6	55
50	19953 9.7	19956 4.5	19922 -.2	19865 -4.1	19801 -7.1	19762 -9.1	19693 -10.0	19662 -9.9	19652 -9.0	19666 -7.6	19708 -6.0	19777 -4.6	50
45	22600 14.3	22609 8.5	22580 3.1	22532 -1.6	22480 -5.2	22436 -7.6	22405 -8.8	22394 -8.9	22413 -8.1	22469 -6.7	22573 -5.0	22728 -3.4	45
40	25277 19.3	25321 13.1	25327 7.2	25317 2.2	25302 -1.9	25290 -4.7	25285 -6.3	25296 -6.9	25328 -6.7	25406 -6.0	25546 -5.1	25757 -4.2	40
35	27872 23.9	27978 17.7	28049 12.0	28103 6.9	28149 2.8	28189 -.3	28222 -2.5	28253 -3.9	28299 -4.8	28385 -5.4	28539 -5.8	28780 -6.3	35
30	30222 27.1	30413 21.4	30569 16.2	30706 11.6	30829 7.7	30933 4.5	31014 1.7	31074 -.7	31135 -2.9	31228 -5.1	31389 -7.3	31644 -9.5	30
25	32102 27.7	32391 23.0	32645 18.6	32875 14.7	33081 11.1	33253 7.8	33385 4.5	33483 1.1	33570 -2.4	33682 -6.0	33859 -9.6	34130 -13.0	25
20	33245 25.2	33639 21.5	33996 18.0	34321 14.7	34608 11.3	34846 7.8	35032 4.0	35177 .0	35307 -4.3	35461 -8.6	35678 -12.7	35986 -16.2	20
15	33407 19.4	33901 16.6	34360 13.8	34776 10.8	35137 7.4	35437 3.7	35679 -.4	35861 -4.7	36078 -8.9	36302 -12.7	36594 -15.9	36973 -18.2	15
10	32447 10.6	33021 8.6	33566 6.1	34059 3.1	34494 -.4	34840 -4.3	35139 -8.3	35412 -12.0	35695 -15.1	36026 -17.1	36428 -18.0	36914 -17.7	10
5	30526 -.7	31006 -2.1	31599 -4.3	32138 -7.3	32608 -10.7	33009 -14.3	33368 -17.5	33723 -19.8	34116 -20.7	34578 -20.0	35123 -17.7	35748 -14.0	5
0	27466 -13.9	28049 -14.7	28627 -16.4	29164 -18.9	29641 -21.5	30271 -23.9	30487 -25.4	30934 -25.3	31453 -23.3	32065 -19.3	32771 -15.6	33555 -6.7	0
LAT / E. LONG	0	5	10	15	20	25	30	35	40	45	50	55	LAT / E. LONG

nT
(units: nT)

NORTH COMPONENT (X) WMM-90

E. LONG LAT	60	65	70	75	80	85	90	95	100	105	110	115	E. LONG LAT
90	1973 -16.3	1827 -16.5	1716 -16.4	1595 -16.3	1460 -16.0	1316 -15.6	1156 -15.1	994 -14.5	821 -13.7	643 -12.9	459 -12.0	273 -10.9	90
85	3128 -20.7	2868 -20.2	2611 -19.6	2362 -19.0	2128 -18.2	1913 -17.4	1721 -16.4	1556 -15.5	1418 -14.5	1310 -13.6	1232 -12.6	1181 -11.7	85
80	4628 -23.8	4252 -23.4	3897 -22.8	3547 -22.1	3231 -21.4	2960 -20.5	2739 -19.6	2574 -18.7	2470 -17.8	2430 -16.9	2452 -16.1	2534 -15.4	80
75	6501 -24.6	6076 -24.6	5661 -24.5	5279 -24.3	4918 -24.0	4619 -23.6	4386 -23.2	4231 -22.7	4160 -22.1	4180 -21.5	4291 -20.9	4489 -20.4	75
70	8738 -22.5	8335 -23.0	7936 -23.5	7558 -24.0	7216 -24.5	6929 -24.9	6712 -25.2	6581 -25.3	6547 -25.4	6619 -25.4	6799 -25.3	7085 -25.1	70
65	11270 -18.1	10951 -18.9	10632 -19.8	10326 -20.9	10048 -22.0	9817 -23.2	9649 -24.3	9562 -25.4	9570 -26.3	9686 -27.0	9909 -27.5	10244 -27.8	65
60	14009 -12.5	13820 -13.1	13628 -14.0	13443 -15.3	13276 -17.0	13140 -18.8	13052 -20.7	13027 -22.6	13080 -24.4	13223 -25.9	13465 -27.1	13808 -27.9	60
55	16889 -7.2	16850 -7.2	16812 -7.9	16778 -9.1	16750 -10.9	16737 -13.1	16748 -15.5	16796 -18.1	16893 -20.5	17051 -22.7	17282 -24.4	17588 -25.7	55
50	19870 -3.5	19981 -3.0	20101 -3.2	20225 -4.2	20347 -5.9	20465 -8.2	20582 -10.9	20702 -13.7	20834 -16.5	20990 -18.9	21181 -20.8	21414 -22.1	50
45	22932 -2.2	23173 -1.8	23436 -1.8	23706 -2.5	23968 -4.0	24209 -6.2	24421 -8.8	24604 -11.5	24758 -14.0	24892 -16.1	25018 -17.6	25148 -18.5	45
40	26039 -3.5	26379 -3.4	26759 -3.7	27145 -4.6	27520 -6.1	27862 -8.0	28152 -10.2	28379 -12.3	28537 -14.0	28632 -15.1	28675 -15.5	28682 -15.0	40
35	29110 -7.3	29515 -7.4	29969 -8.8	30441 -10.0	30898 -11.5	31311 -13.0	31653 -14.4	31903 -15.5	32049 -15.9	32092 -15.6	32043 -14.3	31921 -12.2	35
30	31999 -11.6	32440 -13.5	32939 -15.2	33459 -16.7	33966 -17.9	34418 -18.9	34785 -19.3	35038 -19.1	35158 -18.1	35143 -16.0	35004 -13.0	34762 -9.2	30
25	34504 -16.1	34967 -18.6	35489 -20.6	36034 -21.9	36561 -22.6	37030 -22.6	37401 -22.0	37642 -20.4	37730 -18.0	37660 -14.6	37445 -10.3	37105 -5.3	25
20	36392 -19.2	36881 -21.3	37425 -22.6	37985 -23.0	38523 -22.7	38994 -21.6	39359 -19.8	39582 -17.2	39642 -13.9	39532 -9.8	39267 -5.0	38865 .0	20
15	37439 -19.6	37976 -20.0	38557 -19.7	39145 -18.5	39699 -16.8	40179 -14.5	40544 -11.8	40760 -8.6	40810 -5.1	40689 -1.3	40410 2.7	39993 6.6	15
10	37476 -16.4	38095 -14.3	38742 -11.5	39382 -9.4	39978 -5.2	40489 -1.9	40879 1.2	41119 4.3	41193 7.1	41101 9.6	40856 11.7	40474 13.3	10
5	36438 -9.4	37169 -4.4	37912 .7	38636 5.5	39305 9.8	39883 13.5	40337 16.4	40643 19.6	40790 20.0	40778 20.4	40618 20.0	40324 18.7	5
0	35391 .7	35252 8.6	36112 14.6	36941 20.1	37710 24.7	38388 27.9	38946 30.0	39365 30.8	39634 30.3	39751 28.5	39724 25.3	39564 21.2	0
LAT E. LONG	60	65	70	75	80	85	90	95	100	105	110	115	LAT E. LONG

NORTH COMPONENT (X) WMM-90

E. LONG / LAT	120	125	130	135	140	145	150	155	160	165	170	175	LAT
90	84 -9.8	-106 -8.6	-295 -7.4	-481 -6.1	-664 -4.7	-842 -3.3	-1016 -1.9	-1177 -.5	-1332 1.0	-1477 2.4	-1610 3.8	-1731 5.2	90
85	1155 -10.9	1152 -10.0	1166 -9.3	1194 -8.5	1229 -7.9	1265 -7.2	1298 -6.6	1321 -6.0	1331 -5.4	1321 -4.7	1290 -4.0	1235 -3.3	85
80	2670 -14.8	2853 -14.2	3071 -13.9	3316 -13.6	3567 -13.5	3818 -13.4	4053 -13.4	4258 -13.5	4422 -13.5	4536 -13.5	4587 -13.4	4576 -13.1	80
75	4767 -20.0	5113 -19.7	5511 -19.6	5942 -19.5	6385 -19.6	6819 -19.9	7223 -20.2	7576 -20.6	7860 -21.0	8061 -21.3	8168 -21.4	8172 -21.3	75
70	7468 -24.9	7933 -24.8	8459 -24.7	9023 -24.6	9598 -24.6	10155 -24.7	10667 -24.9	11110 -25.1	11462 -25.2	11705 -25.3	11827 -25.3	11821 -25.1	70
65	10681 -28.0	11204 -27.9	11791 -27.8	12413 -27.5	13039 -27.1	13639 -26.6	14181 -26.1	14640 -25.5	14993 -24.9	15225 -24.3	15324 -23.6	15285 -22.9	65
60	14243 -28.4	14757 -28.5	15328 -28.2	15925 -27.5	16517 -26.6	17072 -25.3	17560 -23.8	17956 -22.1	18243 -20.3	18407 -18.6	18443 -16.9	18350 -15.5	60
55	17968 -26.4	18409 -26.5	18891 -26.0	19387 -24.9	19865 -23.4	20295 -21.5	20652 -18.9	20915 -16.2	21072 -13.3	21117 -10.5	21052 -7.8	20881 -5.6	55
50	21691 -22.7	22006 -22.5	22340 -21.8	22671 -20.4	22971 -18.5	23216 -16.1	23381 -13.3	23457 -10.1	23436 -6.7	23322 -3.2	23121 .1	22847 3.0	50
45	25288 -18.2	25436 -17.5	25581 -16.3	25704 -14.7	25783 -12.8	25795 -10.7	25739 -8.4	25595 -5.7	25369 -2.8	25070 .3	24712 3.6	24315 6.6	45
40	28664 -13.8	28626 -12.1	28560 -10.3	28457 -8.6	28292 -7.2	28063 -6.1	27761 -5.1	27388 -4.2	26951 -2.9	26463 -1.2	25943 1.0	25417 3.6	40
35	31741 -9.5	31513 -6.6	31236 -4.1	30901 -2.4	30502 -1.8	30036 -2.2	29501 -3.4	28912 -5.0	28279 -6.5	27619 -7.1	26955 -6.7	26316 -5.1	35
30	34435 -5.1	34036 -1.2	33568 1.9	33029 3.5	32419 3.3	31742 1.2	31011 -2.4	30242 -6.8	29451 -11.2	28658 -14.7	27888 -16.5	27171 -16.2	30
25	36661 -.3	36129 4.2	35511 7.5	34813 8.8	34042 7.8	33211 4.5	32316 -.9	31446 -7.5	30556 -14.4	29687 -20.3	28865 -24.3	28119 -25.5	25
20	38349 4.9	37732 9.2	37023 12.0	36230 12.9	35368 11.5	34456 7.6	33518 1.6	32578 -5.8	31659 -13.9	30781 -21.1	29968 -26.5	29244 -29.2	20
15	39456 10.2	38814 13.1	38080 14.9	37266 15.2	36392 13.6	35482 10.2	34562 4.9	33655 -1.7	32783 -9.0	31962 -16.0	31213 -21.8	30555 -25.4	15
10	39973 14.5	39368 15.2	38675 15.3	37911 14.8	37101 13.5	36271 11.3	35444 8.1	34642 4.0	33879 -1.0	33169 -6.2	32527 -11.2	31963 -15.3	10
5	39912 16.9	39398 14.9	38803 12.9	38150 11.5	37464 10.6	36771 10.1	36091 9.7	35440 9.0	34826 7.5	34260 5.1	33745 1.8	33288 -2.0	5
0	39284 16.5	38905 11.9	38450 8.1	37947 5.7	37421 5.1	36896 6.2	36386 8.5	35902 11.1	35450 13.3	35033 14.0	34650 12.9	34297 9.7	0
LAT / E. LONG	120	125	130	135	140	145	150	155	160	165	170	175	LAT / E. LONG

NORTH COMPONENT (X) WMM-90

E. LONG LAT	180	185	190	195	200	205	210	215	220	225	230	235	E. LONG LAT
90	-1839 6.5	-1923 7.4	-2012 8.1	-2073 10.3	-2124 11.3	-2156 12.3	-2172 13.2	-2171 14.0	-2153 14.7	-2120 15.3	-2070 15.8	-2004 16.1	90
85	1153 -2.4	1047 -1.5	915 -.5	761 .6	588 1.7	400 3.0	203 4.3	2 5.7	-197 7.1	-387 8.5	-562 9.9	-715 11.2	85
80	4496 -12.7	4349 -12.0	4136 -11.0	3863 -9.8	3537 -8.2	3166 -6.4	2763 -4.4	2338 -2.2	1906 .2	1478 2.7	1069 5.2	691 7.8	80
75	8011 -21.0	7865 -20.3	7560 -19.2	7162 -17.7	6684 -15.7	6139 -13.3	5543 -10.5	4914 -7.4	4270 -4.0	3630 -.4	3012 3.2	2434 6.7	75
70	11685 -24.6	11420 -23.8	11034 -22.6	10537 -20.8	9943 -18.6	9269 -15.9	8554 -12.5	7758 -8.8	6962 -4.8	6168 -.5	5397 3.8	4670 8.0	70
65	15109 -22.1	14900 -21.1	14365 -19.9	13816 -18.3	13168 -16.2	12438 -13.6	11643 -10.4	10805 -6.7	9944 -2.6	9080 1.7	8235 6.1	7428 10.4	65
60	18132 -14.2	17796 -13.1	17349 -12.1	16907 -11.0	16169 -9.6	15463 -7.8	14699 -5.5	13893 -2.6	13061 .9	12222 4.6	11390 8.5	10583 12.3	60
55	20613 -3.8	20258 -2.6	19825 -1.9	19323 -1.5	18762 -1.2	18148 -.7	17491 .3	16801 1.9	16085 4.0	15355 6.6	14619 9.4	13888 12.2	55
50	22514 5.1	22135 6.5	21726 7.1	21288 6.9	20830 6.3	20353 5.6	19856 5.2	19335 5.1	18795 5.7	18235 6.7	17657 8.1	17064 9.6	50
45	23899 9.1	23686 10.9	23091 11.7	22721 11.7	22376 10.8	22068 9.6	21727 8.2	21401 6.8	21060 5.8	20698 5.2	20309 4.8	19969 4.6	45
40	24913 6.3	24658 8.8	24070 10.6	23759 11.7	23517 11.7	23329 10.9	23173 9.4	23030 7.4	22879 5.1	22710 2.8	22510 .4	22272 -1.8	40
35	25734 -2.4	25242 .9	24862 4.4	24598 7.5	24461 9.3	24367 10.1	24347 9.5	24351 7.6	24358 4.5	24351 .6	24317 -3.9	24246 -8.6	35
30	26542 -13.9	26034 -9.8	25666 -4.7	25442 .6	25347 5.1	25352 8.1	25422 9.1	25528 7.8	25645 4.3	25757 -1.1	25852 -7.8	25916 -15.1	30
25	27482 -23.6	26982 -19.3	26636 -13.3	26442 -6.2	26381 .5	26423 5.6	26535 8.1	26689 7.6	26864 3.8	27046 -2.8	27223 -11.5	27378 -21.2	25
20	28638 -28.7	28169 -25.0	27847 -18.7	27666 -11.1	27606 -3.6	27640 2.5	27742 5.8	27890 5.6	28069 1.6	28267 -5.9	28473 -16.0	28667 -27.3	20
15	30007 -26.3	29580 -24.3	29276 -19.7	29085 -13.6	28990 -7.1	28973 -1.9	29015 1.1	29105 .5	29233 -3.9	29391 -11.7	29566 -22.2	29742 -33.9	15
10	31497 -17.7	31101 -18.2	30801 -16.8	30577 -14.0	30417 -10.6	30312 -7.9	30255 -6.9	30244 -8.5	30273 -13.2	30338 -20.7	30429 -30.2	30528 -40.6	10
5	32886 -6.0	32534 -9.4	32226 -12.1	31953 -13.8	31711 -15.0	31503 -16.1	31326 -17.8	31186 -20.9	31083 -25.5	31017 -31.7	30980 -39.0	30962 -46.5	5
0	33974 4.7	33642 -1.5	33322 -8.1	33000 -14.9	32679 -20.3	32367 -25.5	32074 -30.0	31807 -34.2	31570 -38.1	31363 -42.4	31184 -46.3	31037 -49.7	0
LAT E. LONG	180	185	190	195	200	205	210	215	220	225	230	235	LAT E. LONG

NORTH COMPONENT (X) WMM-90

E. LONG LAT	240	245	250	255	260	265	270	275	280	285	290	295	E. LONG LAT
90	-1923 16.3	-1827 16.5	-1718 16.4	-1595 16.3	-1460 16.0	-1316 15.6	-1158 15.1	-994 14.5	-821 13.7	-643 12.9	-459 12.0	-273 10.9	90
85	-841 12.4	-936 13.6	-989 14.6	-1004 15.3	-975 15.9	-900 16.3	-780 16.5	-616 16.4	-408 16.1	-161 15.5	123 14.6	437 13.5	85
80	356 10.2	74 12.5	-165 14.5	-294 16.4	-367 18.0	-362 19.3	-277 20.2	-113 20.7	125 20.9	436 20.6	804 20.0	1228 19.0	80
75	1911 10.2	1461 13.4	1094 16.4	821 19.1	652 21.4	593 23.3	637 24.9	792 26.0	1049 26.7	1402 27.0	1839 26.8	2346 26.1	75
70	4004 12.0	3418 15.7	2929 19.1	2548 22.1	2288 24.7	2156 27.1	2155 29.1	2286 30.7	2543 32.0	2916 33.0	3391 33.4	3953 33.5	70
65	6678 14.4	6004 18.1	5424 21.3	4954 24.2	4610 26.7	4404 29.1	4343 31.4	4429 33.5	4658 35.5	5022 37.2	5504 38.6	6083 39.4	65
60	9816 15.8	9109 18.9	8480 21.6	7948 24.0	7533 26.3	7252 28.6	7118 31.0	7140 33.7	7317 36.5	7641 39.2	8096 41.7	8659 43.6	60
55	13175 14.8	12494 17.1	11863 19.1	11304 20.9	10841 22.8	10496 25.0	10290 27.8	10236 31.1	10340 34.9	10598 38.9	10997 42.7	11514 45.8	55
50	16462 11.0	15863 12.2	15281 13.3	14739 14.5	14262 16.1	13877 18.5	13610 21.7	13481 26.0	13503 31.0	13679 36.4	14000 41.7	14447 46.2	50
45	19440 4.4	18966 4.3	18478 4.4	17996 5.0	17565 6.5	17152 9.1	16849 13.2	16654 18.6	16595 25.0	16680 31.9	16909 38.8	17270 44.8	45
40	21991 -3.9	21667 -5.7	21303 -6.8	20914 -6.9	20521 -5.6	20148 -2.6	19828 2.5	19588 8.9	19454 16.7	19447 25.5	19576 33.9	19839 41.2	40
35	24128 -13.1	23954 -16.9	23723 -19.6	23439 -20.6	23118 -19.6	22782 -16.2	22460 -10.6	22183 -2.9	21982 6.5	21886 16.2	21909 26.0	22067 35.0	35
30	25934 -22.2	25891 -29.3	25776 -32.7	25587 -34.8	25331 -34.2	25028 -30.8	24704 -24.6	24393 -16.2	24128 -6.2	23942 4.7	23863 15.5	23912 25.7	30
25	27492 -30.8	27542 -39.0	27510 -45.1	27386 -49.2	27173 -48.1	26884 -44.9	26549 -38.6	26199 -30.0	25872 -19.7	25603 -8.6	25426 2.7	25369 13.5	25
20	28825 -38.5	28921 -48.2	28929 -55.3	28835 -59.2	28636 -59.5	28345 -56.5	27987 -50.6	27596 -42.5	27212 -32.8	26869 -22.3	26605 -11.4	26450 -.8	20
15	29890 -45.3	29982 -55.2	29991 -62.3	29897 -66.1	29695 -66.6	29393 -63.9	29014 -58.8	28590 -51.8	28158 -43.5	27755 -34.5	27417 -25.1	27177 -15.6	15
10	30614 -50.6	30660 -59.0	30640 -64.8	30532 -67.8	30325 -67.9	30021 -65.6	29634 -61.6	29192 -56.2	28729 -50.2	28281 -43.6	27883 -36.6	27567 -29.1	10
5	30949 -53.4	30921 -58.8	30855 -62.2	30730 -65.5	30526 -63.0	30234 -61.1	29860 -58.5	29420 -55.2	28944 -51.8	28464 -48.3	28016 -44.4	27625 -38.6	5
0	30905 -52.4	30792 -53.9	30671 -54.3	30526 -53.7	30330 -52.5	30063 -51.1	29716 -50.0	29294 -49.2	28817 -48.9	28313 -48.7	27914 -48.2	27547 -47.1	0
LAT E. LONG	240	245	250	255	260	265	270	275	280	285	290	295	LAT E. LONG

NORTH COMPONENT (X) WMM-90

E. LONG LAT	300	305	310	315	320	325	330	335	340	345	350	355	E. LONG LAT
90	-84 9.8	106 8.6	295 7.4	481 6.1	666 4.7	842 3.3	1016 1.9	1177 .5	1332 -1.0	1477 -2.4	1610 -3.8	1731 -5.2	90
85	772 12.2	1135 10.7	1528 8.9	1883 7.0	2257 5.0	2626 2.9	2975 .7	3306 -1.6	3606 -3.8	3876 -6.0	4109 -8.2	4301 -10.2	85
80	1694 17.6	2193 15.9	2716 13.8	3240 11.5	3765 8.9	4276 6.1	4762 3.2	5215 .7	5626 -2.8	5989 -5.7	6297 -8.5	6546 -11.1	80
75	2910 24.9	3516 23.2	4160 21.1	4775 18.5	5400 15.5	6004 12.2	6573 8.7	7096 5.1	7566 1.4	7975 -2.1	8319 -5.5	8594 -8.7	75
70	4578 32.6	5249 31.3	5941 29.2	6636 26.6	7314 23.4	7960 19.7	8559 15.7	9102 11.5	9581 7.3	9991 3.2	10329 -.7	10595 -4.4	70
65	6735 39.4	7433 38.7	8152 37.0	8866 34.5	9556 31.2	10202 27.3	10792 22.9	11315 18.3	11767 13.6	12165 9.0	12447 4.7	12678 .6	65
60	9302 44.6	9995 44.6	10706 43.5	11408 41.5	12079 38.1	12698 34.1	13256 29.5	13739 24.7	14148 19.7	14479 14.7	14735 9.9	14918 5.4	60
55	12120 48.0	12779 49.9	13460 48.4	14132 46.6	14768 43.6	15351 39.7	15869 35.3	16315 30.4	16684 25.3	16976 20.2	17191 15.1	17335 10.1	55
50	14993 49.6	15603 51.5	16242 51.7	16876 50.5	17481 48.0	18035 44.5	18527 40.4	18950 35.8	19300 30.9	19573 25.7	19771 20.4	19895 15.0	50
45	17740 49.5	18290 52.5	18886 53.7	19489 53.3	20075 51.5	20622 48.7	21116 45.2	21546 41.1	21908 36.5	22196 31.5	22404 26.0	22537 20.3	45
40	20226 47.3	20706 51.6	21257 54.1	21842 54.8	22433 54.1	23033 52.2	23533 49.4	24008 46.0	24418 41.8	24752 37.0	25005 31.6	25178 25.6	40
35	22356 42.5	22765 48.3	23272 52.3	23848 54.4	24463 55.0	25084 54.3	25685 52.5	26241 49.7	26733 46.0	27146 41.4	27471 36.1	27709 30.7	35
30	24100 34.6	24428 41.9	24887 47.4	25456 51.2	26101 53.3	26788 53.8	27478 53.0	28134 50.9	28727 47.7	29236 43.5	29651 38.4	29976 32.8	30
25	25453 23.4	25694 31.9	26093 38.9	26639 44.2	27302 47.8	28040 49.7	28806 49.9	29551 48.6	30236 45.9	30837 42.1	31343 37.6	31760 32.7	25
20	26435 9.4	26581 18.6	26902 26.6	27393 33.2	28030 38.1	28768 41.2	29555 42.4	30336 41.9	31069 39.9	31728 36.9	32305 33.1	32806 29.2	20
15	27066 -6.1	27111 2.9	27326 11.3	27716 18.5	28256 24.2	28906 28.2	29622 30.3	30351 30.8	31055 29.7	31713 27.7	32320 25.1	32882 22.3	15
10	27562 -21.4	27290 -13.5	27366 -5.8	27591 1.2	27951 7.2	28418 11.7	28955 14.6	29529 16.0	30112 16.1	30696 15.3	31278 14.0	31863 12.4	10
5	27319 -34.8	27113 -29.0	27015 -22.9	27021 -16.2	27150 -11.4	27325 -6.9	27594 -3.6	27922 -1.4	28306 .0	28745 .6	29243 .6	29798 .2	5
0	26929 -45.1	26570 -42.1	26270 -38.3	26029 -34.1	25848 -29.9	25750 -25.9	25686 -22.3	25723 -19.7	25858 -17.5	26103 -15.7	26461 -14.5	26924 -13.8	0
LAT E. LONG	300	305	310	315	320	325	330	335	340	345	350	355	LAT E. LONG

NORTH COMPONENT (X) WMM-90

E. LONG / LAT	0	5	10	15	20	25	30	35	40	45	50	55	E. LONG / LAT
0	27468 -13.8	28049 -14.7	28621 -18.4	29165 -19.9	29641 -21.5	30071 -23.9	30487 -23.4	30834 -25.4	31453 -23.3	32065 -19.3	32771 -15.6	33555 -6.7	0
-5	24026 -28.3	24696 -28.2	24881 -28.8	25652 -29.6	25893 -30.7	26327 -30.6	26792 -29.6	27334 -26.4	27986 -21.2	28750 -14.9	29619 -5.6	30560 3.5	-5
-10	20479 -43.2	20767 -41.7	21092 -40.4	21438 -39.8	21802 -37.0	22216 -33.8	22720 -29.1	23349 -22.4	24121 -14.4	25028 -5.0	26037 5.0	27108 14.8	-10
-15	17199 -57.5	17265 -54.1	17393 -50.2	17584 -45.2	17858 -38.9	18240 -32.9	18772 -24.6	19472 -15.0	20339 -4.7	21345 5.7	22645 15.6	23590 24.9	-15
-20	14441 -69.5	14298 -64.0	14246 -57.2	14303 -49.7	14496 -39.8	14857 -29.3	15409 -18.0	16153 -6.5	17068 4.6	18110 14.6	19225 22.8	20362 28.7	-20
-25	12343 -77.3	12056 -69.9	11898 -60.7	11568 -49.9	12025 -37.8	12382 -25.0	12946 -12.2	13698 -.7	14600 10.1	15598 18.2	16676 23.6	17670 26.2	-25
-30	10956 -76.3	10615 -70.6	10416 -59.9	10390 -47.8	10558 -34.7	10929 -21.6	11491 -9.3	12207 1.5	13029 9.4	13900 14.5	14772 16.6	15613 16.0	-30
-35	10285 -74.6	9971 -65.4	9813 -54.6	9932 -43.1	10036 -31.2	10418 -19.8	10849 -10.2	11560 -2.7	12258 2.0	12933 3.7	13568 2.8	14148 -.9	-35
-40	10314 -61.6	10071 -55.0	9986 -45.8	10254 -36.3	10282 -27.4	10643 -19.8	11096 -14.1	11590 -10.8	12073 -10.0	12504 -11.5	12861 -15.0	13143 -19.5	-40
-45	10992 -68.3	10816 -41.1	10776 -34.2	10866 -29.1	11069 -23.3	11353 -20.2	11673 -19.1	11980 -20.1	12230 -23.0	12394 -27.3	12461 -32.3	12438 -37.2	-45
-50	12201 -41.8	12256 -26.9	12013 -22.1	12060 -19.5	12173 -18.7	12317 -18.6	12451 -22.9	12533 -27.5	12531 -33.2	12423 -39.2	12205 -44.9	11892 -48.6	-50
-55	13753 -17.2	13583 -13.4	13480 -11.5	13424 -11.7	13390 -14.0	13346 -18.2	13259 -23.9	13097 -30.7	12836 -37.8	12463 -44.6	11979 -50.3	11398 -54.4	-55
-60	15591 -6.9	15149 -4.4	14943 -4.1	14746 -5.8	14533 -9.6	14279 -15.3	13961 -21.7	13556 -29.0	13045 -36.2	12429 -42.9	11698 -48.0	10877 -53.5	-60
-65	16812 -1.6	16496 .0	16170 -.2	15918 -2.3	15422 -6.1	14963 -11.2	14625 -17.2	13793 -23.6	13059 -29.8	12220 -35.4	11280 -39.8	10249 -43.0	-65
-70	17806 -.1	17400 1.0	16953 .7	16456 -.9	15898 -3.7	15245 -7.6	14513 -11.8	13687 -16.6	12763 -21.2	11738 -25.5	10622 -29.1	9424 -33.0	-70
-75	18175 .0	17686 .7	17129 .5	16496 -.4	15782 -2.0	14980 -4.3	14087 -7.0	13101 -10.0	12023 -13.1	10856 -16.1	9608 -18.9	8290 -21.4	-75
-80	17798 1.3	17231 1.5	16573 1.4	15925 .8	14984 -.1	14052 -1.4	13030 -2.9	11921 -4.7	10730 -6.7	9464 -8.7	8130 -10.8	6741 -12.9	-80
-85	16586 5.5	15947 5.1	15199 4.6	14355 4.0	13615 3.2	12385 2.2	11270 1.0	10078 -.2	8815 -1.7	7492 -3.2	6118 -4.8	4704 -6.4	-85
-90	14480 12.4	13775 11.5	12960 10.6	12049 9.6	11046 8.5	9959 7.4	8726 6.1	7566 4.9	6279 3.6	4944 2.3	3571 .9	2171 -.4	-90
LAT / E. LONG	0	5	10	15	20	25	30	35	40	45	50	55	LAT / E. LONG

NORTH COMPONENT (X) WMM-90

E. LONG / LAT	60	65	70	75	80	85	90	95	100	105	110	115	E. LONG / LAT
0	34391 .7	35252 8.0	36112 14.6	36941 20.3	37710 24.7	38388 27.9	38946 30.0	39765 30.8	39634 30.3	39751 28.5	39724 25.3	39564 21.2	0
5	31540 12.5	32529 20.6	33503 27.3	34430 32.4	35316 35.9	36108 37.8	36795 38.3	37357 37.4	37783 35.1	38068 31.4	38210 26.3	38216 20.1	-5
-10	28201 23.5	29287 30.6	30349 35.7	31364 39.0	32328 40.4	33221 40.4	34029 39.1	34737 36.7	35329 33.1	35792 28.4	36118 22.4	36305 15.5	-10
-15	24738 30.8	25864 35.4	26953 37.7	27999 39.2	28999 37.1	29949 35.0	30839 32.2	31659 28.8	32392 24.8	33016 20.2	33514 14.8	33874 8.8	-15
-20	21686 32.2	22570 33.3	23613 32.4	24617 30.0	25585 26.7	26523 23.0	27431 19.3	28303 15.8	29121 12.4	29860 9.1	30493 5.4	30999 1.5	-20
-25	18672 26.2	19631 24.0	20547 20.4	21630 15.9	22290 11.3	23142 7.1	23992 3.5	24841 .9	25676 -1.0	26464 -2.4	27178 -3.6	27786 -4.8	-25
-30	16408 13.1	17158 8.8	17871 3.6	18[illegible]	19247 -6.0	19963 -9.5	20666 -11.8	21419 -12.8	22192 -12.8	22962 -12.0	23693 -10.7	24348 -8.4	-30
-35	14671 -4.9	15151 -9.9	15604 -14.9	16050 -19.0	16507 -22.0	16995 -23.7	17532 -24.1	18127 -23.2	18775 -21.3	19457 -18.6	20139 -15.5	20784 -12.3	-35
-40	13361 -24.3	13539 -28.7	13699 -32.1	13865 -34.1	14058 -34.8	14301 -34.1	14610 -32.3	14999 -29.6	15468 -26.3	16003 -22.6	16577 -18.6	17156 -14.7	-40
-45	12343 -41.3	12215 -44.1	12073 -45.3	11946 -44.8	11854 -43.1	11825 -40.7	11877 -36.6	12025 -37.8	12272 -28.6	12614 -25.1	13029 -21.3	13493 -17.8	-45
-50	11306 -52.6	11078 -53.8	10637 -53.0	10216 -50.6	9836 -47.0	9521 -42.7	9296 -38.4	9178 -34.3	9175 -30.6	9288 -27.5	9505 -24.8	9808 -22.4	-50
-55	10742 -56.5	10039 -56.5	9370 -54.7	8613 -51.4	7948 -47.3	7351 -42.9	6846 -38.8	6452 -35.3	6183 -32.7	6046 -30.8	6039 -29.5	6153 -28.4	-55
-60	9979 -53.1	9031 -53.0	8061 -51.2	7097 -48.4	6170 -45.0	5306 -41.7	4532 -38.7	3871 -36.5	3340 -35.2	2951 -34.6	2709 -34.6	2613 -34.8	-60
-65	9146 -44.7	7991 -45.1	6810 -44.3	5630 -42.8	4481 -41.1	3389 -39.4	2381 -38.1	1482 -37.4	712 -37.4	86 -37.9	-385 -38.8	-697 -39.8	-65
-70	8158 -44.0	6845 -35.2	5309 -35.7	4167 -35.6	2852 -35.6	1588 -35.9	601 -36.2	-686 -38.8	-1652 -37.8	-2480 -39.0	-3156 -40.4	-3678 -41.7	-70
-75	6915 -23.6	5500 -25.4	4066 -27.0	2629 -29.4	1216 -29.7	-152 -31.0	-1452 -32.4	-2665 -33.8	-3771 -35.3	-4754 -36.8	-5601 -38.2	-6302 -39.5	-75
-80	5309 -15.0	3849 -17.0	2376 -19.0	907 -20.9	-539 -22.7	-1945 -24.5	-3293 -26.2	-4567 -27.9	-5750 -29.4	-6829 -30.9	-7793 -32.2	-8631 -33.2	-80
-85	3261 -8.1	1803 -9.9	341 -11.6	-1110 -13.3	-2538 -15.0	-3928 -16.6	-5268 -18.2	-6546 -19.6	-7745 -20.9	-8860 -22.1	-9879 -23.2	-10792 -24.1	-85
-90	-155 -1.7	-967 -3.1	-2092 -4.4	-3486 -5.6	-4860 -6.9	-6198 -8.0	-7489 -9.2	-8723 -10.2	-9889 -11.2	-10981 -12.1	-11990 -12.8	-12907 -13.4	-90
LAT / E. LONG	60	65	70	75	80	85	90	95	100	105	110	115	LAT / E. LONG

NORTH COMPONENT (X) WMM-90

E. LONG / LAT	120	125	130	135	140	145	150	155	160	165	170	175	E. LONG / LAT
0	39284 16.5	38903 11.9	38450 8.1	37947 5.7	37421 5.1	36896 6.2	36386 8.5	35902 11.1	35450 13.3	35033 14.0	34650 12.9	34297 9.7	0
-5	38099 13.4	37860 7.0	37588 1.8	37251 -1.3	36896 -1.9	36540 .1	36196 4.2	35871 9.3	35569 14.1	35288 17.2	35023 19.2	34767 15.8	-5
-10	36362 8.2	36313 1.3	36192 -4.2	36013 -8.0	35817 -8.8	35613 -6.8	35416 -2.2	35226 3.3	35047 9.2	34882 12.6	34726 16.0	34553 14.3	-10
-15	34101 2.4	34214 -3.8	34242 -9.1	34213 -12.7	34153 -14.0	34076 -12.8	33993 -9.6	33912 -4.6	33837 .6	33769 4.9	33698 7.1	33609 8.4	-15
-20	31374 -2.8	31629 -7.2	31789 -11.2	31983 -14.3	31933 -16.2	31959 -16.4	31969 -15.1	31976 -12.6	31987 -9.6	32002 -6.9	32015 -5.3	32009 -5.5	-20
-25	29273 -6.4	26642 -8.3	28911 -10.6	29103 -13.0	29243 -15.2	29351 -16.9	29442 -18.0	29527 -18.3	29619 -18.1	29710 -17.5	29805 -17.1	29887 -17.1	-25
-30	24905 -8.3	25355 -7.6	25707 -8.4	25981 -9.8	26198 -12.0	26381 -14.8	26545 -17.7	26708 -20.9	26873 -22.7	27047 -24.2	27227 -26.9	27401 -24.9	-30
-35	21363 -9.4	21859 -7.3	22272 -6.4	22614 -6.7	22903 -8.5	23159 -11.5	23401 -15.2	23641 -19.2	23890 -22.9	24150 -25.6	24419 -27.0	24689 -27.1	-35
-40	17709 -11.1	18215 -8.2	18665 -6.3	19063 -5.8	19423 -6.8	19759 -9.1	20085 -12.5	20415 -16.3	20756 -20.0	21107 -22.8	21471 -24.4	21840 -24.4	-40
-45	13973 -14.5	14451 -11.7	14913 -9.6	15355 -8.5	15783 -8.5	16200 -9.5	16620 -11.5	17048 -14.0	17489 -16.5	17943 -18.4	18407 -19.5	18877 -19.5	-45
-50	10177 -20.1	10591 -18.1	11035 -16.3	11499 -14.8	11979 -13.9	12475 -13.5	12987 -13.6	13517 -14.2	14062 -14.8	14620 -15.4	15187 -15.6	15755 -15.4	-50
-55	6374 -27.5	6686 -26.4	7074 -25.1	7525 -23.6	8028 -22.0	8576 -20.5	9161 -19.0	9776 -17.7	10416 -16.6	11066 -15.7	11725 -15.1	12381 -14.6	-55
-60	2658 -35.0	2929 -34.9	3116 -34.0	3506 -32.7	3986 -30.9	4535 -28.7	5147 -26.2	5806 -23.8	6499 -21.5	7214 -19.6	7939 -18.3	8663 -17.7	-60
-65	-851 -40.6	-952 -41.0	-711 -40.7	-639 -39.7	-52 -38.0	436 -35.8	1008 -33.1	1647 -30.4	2337 -27.7	3063 -25.5	3811 -23.9	4569 -23.1	-65
-70	-4038 -42.8	-4235 -43.3	-4278 -43.3	-4177 -42.7	-3961 -41.2	-3587 -38.6	-3128 -37.2	-2581 -35.0	-1961 -32.7	-1285 -30.6	-564 -29.1	188 -28.1	-70
-75	-6852 -40.5	-7249 -41.1	-7494 -41.2	-7591 -40.9	-7549 -40.1	-7377 -38.9	-7086 -37.3	-6687 -35.8	-6194 -34.1	-5618 -32.5	-4971 -31.1	-4264 -30.1	-75
-80	-9316 -34.9	-9906 -34.6	-10338 -34.9	-10622 -34.8	-10774 -34.5	-10793 -33.9	-10685 -33.1	-10456 -32.1	-10113 -31.0	-9665 -29.6	-9118 -28.7	-8482 -27.7	-80
-85	-11592 -24.8	-14274 -25.1	-12832 -25.6	-13263 -25.8	-13365 -25.7	-13737 -25.5	-13791 -25.1	-13698 -24.8	-13491 -23.9	-13162 -23.2	-12718 -22.3	-12162 -21.3	-85
-90	-13776 -14.1	-14440 -14.6	-15046 -15.0	-15534 -15.2	-15906 -15.4	-16157 -15.4	-16285 -15.3	-16288 -15.1	-16168 -14.8	-15925 -14.3	-15561 -13.8	-15078 -13.1	-90
LAT / E. LONG	120	125	130	135	140	145	150	155	160	165	170	175	LAT / E. LONG

NORTH COMPONENT (X) WMM-90

E. LONG / LAT	180	185	190	195	200	205	210	215	220	225	230	235	E. LONG / LAT
0	33964 4.7	33642 -1.5	33322 -8.1	33000 -14.5	32679 -20.3	32367 -25.5	32076 -30.0	31807 -34.2	31570 -38.3	31363 -42.4	31184 -46.3	31033 -49.7	0
-5	34500 10.5	34210 2.6	33887 -6.8	33533 -16.7	33156 -26.1	32772 -34.2	32393 -40.6	32027 -45.2	31681 -48.1	31356 -49.2	31052 -49.4	30782 -48.4	-5
-10	34350 9.5	34102 1.4	33798 -8.9	33445 -20.1	33056 -30.9	32643 -40.0	32227 -46.7	31815 -50.6	31412 -51.5	31020 -49.9	30643 -46.3	30290 -41.5	-10
-15	33680 2.5	33294 -4.4	33042 -13.5	32729 -23.5	32372 -33.1	31988 -41.1	31593 -46.3	31196 -48.3	30799 -47.1	30401 -42.9	30004 -36.6	29615 -29.2	-15
-20	31965 -7.9	31860 -12.5	31691 -18.6	31461 -25.4	31185 -31.8	30879 -36.7	30559 -39.2	30231 -38.8	29895 -35.4	29545 -29.6	29178 -22.0	28795 -14.0	-20
-25	29935 -17.9	29935 -19.7	29876 -22.1	29763 -24.7	29605 -26.9	29416 -28.0	29208 -27.4	28985 -24.7	28744 -19.9	28475 -13.5	28170 -6.2	27824 .9	-25
-30	27552 -24.4	27667 -23.6	27737 -22.6	27759 -21.4	27739 -19.8	27687 -17.6	27608 -14.5	27504 -10.4	27370 -5.2	27196 .5	26966 6.3	26679 11.3	-30
-35	24948 -25.8	25182 -21.4	25382 -20.3	25543 -16.7	25664 -12.8	25747 -8.8	25795 -4.6	25806 -.3	25776 4.0	25691 8.2	25547 11.8	25338 14.4	-35
-40	22205 -22.9	22553 -20.2	22875 -16.5	23163 -12.4	23411 -8.3	23615 -4.4	23776 -.8	23889 2.4	23951 5.1	23959 7.2	23909 8.7	23799 9.2	-40
-45	19343 -18.3	19795 -16.2	20226 -13.5	20618 -10.8	20971 -7.9	21278 -5.7	21536 -4.0	21738 -2.8	21895 -2.1	22001 -1.9	22061 -2.0	22078 -2.8	-45
-50	16315 -14.8	16860 -13.9	17376 -12.9	17861 -12.2	18301 -11.9	18696 -12.0	19039 -12.7	19338 -13.7	19595 -14.8	19817 -15.9	20012 -16.8	20188 -17.5	-50
-55	13026 -14.5	13651 -14.8	14247 -15.6	14808 -16.9	15328 -18.8	15807 -21.1	16247 -23.7	16652 -26.2	17032 -28.5	17397 -30.1	17755 -31.0	18116 -31.1	-55
-60	9376 -17.8	10070 -18.8	10738 -20.6	11376 -23.1	11983 -26.2	12560 -29.6	13113 -33.0	13649 -36.1	14178 -38.5	14710 -40.0	15255 -40.4	15819 -39.6	-60
-65	5327 -23.1	6077 -24.1	6814 -25.9	7535 -28.5	8240 -31.5	8936 -34.7	9622 -37.8	10312 -40.3	11013 -42.1	11731 -42.9	12475 -42.5	13247 -41.1	-65
-70	962 -27.8	1750 -28.9	2548 -29.3	3356 -30.0	4167 -32.6	4990 -34.8	5827 -36.6	6683 -38.0	7563 -38.7	8470 -38.7	9407 -37.7	10373 -36.0	-70
-75	-3504 -29.4	-2699 -28.1	-1855 -29.1	-975 -29.4	-61 -29.8	886 -30.5	1867 -30.6	2880 -30.7	3926 -30.3	5004 -29.6	6111 -28.3	7243 -26.7	-75
-80	-7763 -26.7	-6967 -25.8	-6102 -25.0	-5172 -24.2	-4183 -23.5	-3140 -22.8	-2047 -22.0	-909 -21.1	269 -20.0	1482 -18.9	2722 -17.6	3982 -16.2	-80
-85	-11500 -20.3	-10739 -19.2	-9884 -18.1	-8943 -16.9	-7923 -15.7	-6829 -14.5	-5673 -13.2	-4460 -12.0	-3200 -10.7	-1901 -9.4	-572 -8.1	777 -6.9	-85
-90	-14480 -12.4	-13772 -11.5	-12960 -10.6	-12049 -9.6	-11046 -8.5	-9959 -7.4	-8796 -6.1	-7568 -4.9	-6279 -3.6	-4944 -2.3	-3571 -.9	-2171 .4	-90
LAT / E. LONG	180	185	190	195	200	205	210	215	220	225	230	235	LAT / E. LONG

NORTH COMPONENT (X) WMM-90

E. LONG / LAT	240	245	250	255	260	265	270	275	280	285	290	295	E. LONG / LAT
0	30905 -52.4	30793 -51.9	30671 -52.3	30526 -53.7	30330 -52.5	30063 -51.1	29716 -50.0	29294 -49.7	28817 -48.9	28313 -48.7	27814 -48.2	27347 -47.1	0
-5	30249 -46.8	30167 -44.4	30171 -41.9	29998 -39.8	29802 -38.3	29556 -37.8	29233 -38.4	28831 -40.1	28357 -43.0	27832 -46.0	27284 -48.9	26733 -51.1	-5
-10	29970 -36.1	29692 -30.6	29451 -26.7	29236 -23.9	29016 -22.9	28762 -24.8	28648 -26.8	28056 -31.8	27583 -36.4	27038 -42.3	26441 -48.0	25811 -53.0	-10
-15	29246 -21.9	28902 -15.5	28593 -11.0	28311 -9.8	28040 -9.2	27753 -12.1	27422 -17.2	27026 -24.9	26546 -31.6	25985 -39.6	25351 -47.3	24658 -54.3	-15
-20	28406 -6.5	28016 -.7	27643 2.6	27289 2.9	26949 .4	26607 -4.8	26242 -12.1	25827 -20.7	25343 -30.1	24777 -39.4	24127 -48.3	23398 -56.4	-20
-25	27443 6.7	27036 10.5	26620 11.5	26208 9.5	25808 4.6	25417 -2.7	25019 -11.7	24594 -21.7	24115 -32.0	23561 -42.0	22920 -51.3	22189 -59.7	-25
-30	26335 14.7	25946 15.9	25528 14.4	25102 10.2	24693 3.4	24277 -5.2	23877 -15.2	23464 -25.8	23012 -36.3	22494 -46.3	21890 -55.4	21189 -63.6	-30
-35	25062 15.4	24739 14.3	24377 11.1	24001 5.6	23626 -1.9	23264 -10.8	22911 -20.7	22552 -31.0	22160 -41.0	21706 -50.5	21163 -59.3	20518 -67.1	-35
-40	23656 8.5	23423 6.4	23181 2.7	22924 -2.7	22668 -9.5	22418 -17.4	22172 -26.1	21914 -35.2	21619 -44.2	21258 -52.9	20799 -61.1	20228 -68.4	-40
-45	22059 -3.8	22012 -5.7	21947 -8.5	21874 -12.3	21798 -17.2	21722 -23.0	21637 -29.7	21525 -37.0	21362 -44.6	21118 -52.3	20767 -59.7	20291 -66.6	-45
-50	20350 -18.1	20506 -18.7	20658 -19.7	20810 -21.1	20959 -23.4	21096 -26.6	21209 -30.8	21277 -36.0	21276 -41.9	21174 -48.4	20952 -55.0	20592 -61.4	-50
-55	18485 -30.5	18865 -29.4	19255 -28.2	19649 -27.3	20037 -27.0	20406 -27.7	20730 -29.8	20993 -32.7	21168 -36.9	21230 -42.1	21159 -47.7	20943 -53.4	-55
-60	16407 -37.8	17016 -35.3	17640 -32.6	18269 -29.9	18886 -27.8	19473 -26.6	20007 -26.7	20465 -28.2	20822 -30.9	21058 -34.7	21158 -39.2	21114 -43.8	-60
-65	14047 -38.6	14870 -35.5	15707 -32.1	16544 -28.7	17363 -25.9	18146 -23.9	18864 -23.0	19502 -23.3	20038 -24.8	20454 -27.3	20738 -30.5	20886 -34.0	-65
-70	11365 -33.5	12376 -30.6	13389 -27.4	14398 -24.4	15382 -21.8	16323 -19.8	17202 -18.6	18001 -18.4	18704 -19.1	19296 -20.5	19770 -22.4	20120 -24.6	-70
-75	8393 -24.6	9552 -22.4	10710 -20.1	11853 -17.9	12966 -16.0	14036 -14.5	15048 -13.5	15986 -13.1	16839 -13.2	17597 -13.8	18252 -14.7	18800 -15.7	-75
-80	5254 -14.6	6528 -13.1	7795 -11.6	9042 -10.3	10259 -9.0	11434 -8.0	12555 -7.3	13613 -6.8	14598 -6.5	15501 -6.4	16315 -6.5	17036 -6.8	-80
-85	2137 -5.6	3497 -4.4	4848 -3.3	6180 -2.2	7483 -1.3	8746 -.4	9961 .4	11118 1.1	12210 1.7	13228 2.2	14165 2.7	15015 3.1	-85
-90	-755 1.7	667 3.1	2085 4.4	3486 5.6	4860 6.9	6198 8.0	7489 9.2	8722 10.2	9889 11.2	10981 12.1	11990 12.8	12907 13.5	-90
LAT / E. LONG	240	245	250	255	260	265	270	275	280	285	290	295	LAT / E. LONG

NORTH COMPONENT (X) WMM-90

E. LONG LAT	300	305	310	315	320	325	330	335	340	345	350	355	E. LONG LAT
0	26929 -45.1	26573 -42.1	26270 -38.3	26029 -34.1	25848 -29.9	25730 -25.9	25684 -22.5	25723 -19.7	25858 -17.5	26103 -15.7	26461 -14.5	26924 -13.8	0
-5	26196 -52.3	25676 -52.3	25173 -51.1	24688 -49.1	24227 -46.6	23810 -43.7	23463 -40.8	23217 -38.0	23099 -35.3	23127 -32.8	23302 -30.7	23612 -29.2	-5
-10	25160 -56.9	24693 -59.6	23812 -61.0	23121 -61.3	22434 -60.7	21780 -59.4	21196 -57.5	20715 -55.2	20373 -52.7	20187 -50.0	20155 -47.4	20263 -45.1	-10
-15	23915 -60.3	23134 -65.0	22321 -68.5	21487 -70.8	20652 -72.0	19845 -72.3	19103 -71.7	18459 -70.4	17943 -68.6	17566 -66.2	17327 -63.5	17213 -60.6	-15
-20	22601 -65.4	21750 -69.4	20859 -74.2	19947 -78.0	19036 -80.7	18152 -82.3	17325 -83.1	16582 -82.9	15941 -81.9	15411 -80.1	14991 -77.4	14670 -73.9	-20
-25	21378 -67.1	20501 -73.4	19579 -76.9	18637 -83.3	17696 -86.8	16782 -89.4	15914 -91.1	15117 -91.7	14395 -91.4	13756 -89.9	13200 -87.2	12728 -83.0	-25
-30	20397 -70.9	19527 -77.2	18605 -82.5	17655 -87.0	16705 -90.6	15778 -93.4	14891 -95.1	14059 -95.9	13290 -95.6	12588 -94.0	11960 -90.9	11411 -86.1	-30
-35	19768 -73.9	18927 -79.8	18019 -84.7	17072 -88.7	16117 -91.7	15178 -93.8	14276 -94.9	13426 -94.9	12638 -93.8	11920 -91.4	11279 -87.5	10729 -81.9	-35
-40	19539 -74.8	18743 -80.3	17863 -84.6	16929 -87.8	15975 -89.8	15032 -90.6	14125 -90.2	13276 -88.7	12497 -86.1	11800 -82.3	11195 -77.3	10695 -71.1	-40
-45	19682 -72.7	18952 -77.7	18122 -81.4	17226 -85.6	16296 -84.4	15373 -83.7	14487 -81.6	13664 -78.2	12922 -73.7	12274 -68.3	11730 -62.2	11299 -55.4	-45
-50	20090 -47.0	19456 -71.8	18712 -74.8	17891 -76.2	17031 -75.9	16179 -73.7	15344 -70.0	14579 -64.9	13898 -58.8	13313 -52.0	12836 -45.6	12462 -38.1	-50
-55	20581 -56.5	20083 -62.6	19471 -65.2	18777 -66.0	18036 -64.8	17285 -61.8	16559 -57.0	15885 -50.9	15283 -43.8	14766 -36.4	14338 -29.1	14002 -22.6	-55
-60	20925 -48.1	20604 -51.5	20170 -53.6	19650 -53.9	19076 -52.4	18480 -49.1	17891 -44.1	17333 -37.9	16824 -30.9	16373 -23.8	15986 -17.0	15656 -11.2	-60
-65	20899 -37.2	20787 -39.8	20566 -41.2	20258 -41.3	19886 -39.8	19475 -36.8	19048 -32.5	18623 -27.1	18216 -21.2	17829 -15.1	17469 -9.5	17133 -4.9	-65
-70	20749 -26.7	20463 -28.3	20473 -29.1	20393 -29.0	20238 -27.8	20027 -25.6	19772 -22.4	19488 -18.5	19183 -14.1	18863 -9.8	18528 -5.7	18177 -2.4	-70
-75	19240 -16.6	19576 -17.4	19811 -17.7	19952 -17.5	20009 -16.7	19989 -15.2	19900 -13.3	19750 -11.0	19543 -8.4	19282 -5.8	18968 -3.4	18601 -1.4	-75
-80	17601 -6.8	18187 -6.9	18614 -6.8	18943 -6.5	19176 -6.0	19315 -5.3	19362 -4.4	19319 -3.3	19189 -2.2	18971 -1.1	18667 -.1	18276 .8	-80
-85	15772 3.4	16431 3.7	16989 4.0	17462 4.3	17788 4.6	18025 4.9	18152 5.2	18167 5.4	18072 5.6	17865 5.7	17547 5.7	17119 5.7	-85
-90	13726 14.1	14440 14.8	15044 15.0	15536 15.2	15906 15.4	16157 15.4	16285 15.3	16288 15.1	16168 14.8	15925 14.3	15561 13.8	15078 13.1	-90
LAT E. LONG	300	305	310	315	320	325	330	335	340	345	350	355	LAT E. LONG

EAST COMPONENT (Y) WMM-90

E. LONG / LAT	0	5	10	15	20	25	30	35	40	45	50	55	E. LONG / LAT
90	-1158 15.1	-994 14.5	-821 13.7	-643 12.9	-659 12.0	-273 10.9	-86 9.8	106 8.6	295 7.4	481 6.1	664 4.7	842 3.3	90
85	-1298 18.1	-946 16.9	-584 15.4	-225 13.9	126 12.2	464 10.5	782 8.7	1076 6.8	1340 5.0	1570 3.2	1764 1.5	1919 -.2	85
80	-1469 21.1	-869 19.3	-465 17.4	35 15.3	519 13.1	879 10.8	1407 8.6	1796 6.4	2133 4.2	2416 2.1	2639 .2	2796 -1.7	80
75	-1622 24.0	-1023 21.7	-622 19.2	169 16.6	742 14.1	1286 11.5	1792 9.0	2250 6.7	2651 4.4	2986 2.4	3245 .4	3422 -1.4	75
70	-1717 26.6	-1061 23.8	-410 20.9	226 17.9	841 14.9	1425 12.1	1970 9.5	2468 7.2	2908 5.0	3281 3.1	3574 1.4	3778 -.1	70
65	-1738 29.3	-1057 25.9	-392 22.4	251 19.0	867 15.6	1450 12.5	1996 9.7	2499 7.3	2949 5.3	3337 3.6	3650 2.3	3875 1.2	65
60	-1688 32.1	-1002 28.3	-345 24.3	278 20.3	865 16.3	1416 12.7	1930 9.5	2405 6.9	2835 4.8	3211 3.3	3522 2.3	3751 1.7	60
55	-1590 35.3	-906 31.2	-267 26.7	322 22.1	863 17.4	1362 13.0	1822 9.1	2245 5.9	2629 3.4	2967 1.9	3248 1.1	3458 1.0	55
50	-1477 39.2	-793 34.9	-174 30.0	379 24.6	870 19.0	1310 13.6	1706 8.7	2065 4.6	2385 1.6	2661 -.3	2887 -1.0	3053 -.6	50
45	-1383 43.6	-695 39.3	-91 34.0	428 27.8	873 21.2	1258 14.8	1596 8.5	1890 3.4	2140 -.3	2343 -2.5	2491 -3.2	2588 -2.6	45
40	-1340 48.2	-644 44.0	-51 38.3	441 31.4	850 23.8	1195 16.1	1488 8.9	1731 2.9	1916 -1.5	2039 -4.0	2100 -4.8	2107 -3.9	40
35	-1372 52.8	-664 48.6	-79 42.6	394 35.0	779 26.6	1102 18.0	1374 10.1	1586 3.5	1723 -1.3	1771 -4.1	1738 -4.8	1644 -3.9	35
30	-1495 56.9	-773 52.6	-191 46.3	271 39.3	647 29.3	970 20.2	1244 12.0	1449 5.3	1555 .4	1540 -2.3	1414 -3.1	1215 -2.1	30
25	-1717 60.3	-979 55.9	-394 49.2	68 40.9	451 31.8	792 22.8	1089 14.7	1308 8.7	1398 3.6	1331 1.1	1119 .3	817 1.0	25
20	-2041 62.8	-1265 58.2	-688 51.4	-213 43.2	195 34.3	571 25.6	906 18.0	1167 12.0	1231 7.8	1118 5.3	827 4.3	430 4.5	20
15	-2462 64.6	-1689 59.9	-1072 55.3	-567 45.3	-117 36.9	308 28.8	686 21.8	951 16.1	1026 12.0	867 9.2	503 7.7	19 7.2	15
10	-2968 65.7	-2184 61.3	-1539 55.1	-987 47.7	-479 39.9	3 32.3	422 25.5	701 19.8	753 15.2	542 11.7	104 9.2	-457 7.6	10
5	-3534 66.3	-2749 62.6	-2070 57.1	-1461 50.4	-886 43.1	-346 35.8	104 28.7	375 22.2	385 16.4	106 11.8	-408 7.8	-1042 5.1	5
0	-4113 67.0	-3338 63.9	-2630 59.2	-1963 53.2	-1323 46.2	-739 38.5	-281 30.4	-45 22.5	-105 15.0	-470 8.4	-1069 3.0	-1770 -.7	0
LAT / E. LONG	0	5	10	15	20	25	30	35	40	45	50	55	LAT / E. LONG

(units: nT)

EAST COMPONENT (Y) WMM-90

E. LONG / LAT	60	65	70	75	80	85	90	95	100	105	110	115	LAT
90	1016 1.9	1177 .5	1336 -1.0	1677 -2.4	1610 -3.8	1731 -5.2	1839 -6.5	1933 -7.8	2012 -9.1	2076 -10.2	2124 -11.3	2156 -12.3	90
85	2034 -1.8	2102 -3.3	2145 -4.7	2144 -5.9	2108 -7.1	2042 -8.0	1950 -8.9	1837 -9.6	1710 -10.2	1574 -10.6	1435 -11.0	1300 -11.2	85
80	2884 -3.4	2904 -4.9	2854 -6.3	2738 -7.5	2562 -8.5	2332 -9.3	2057 -9.9	1749 -10.3	1419 -10.6	1081 -10.6	750 -10.5	439 -10.2	80
75	3510 -3.0	3505 -4.5	3405 -5.8	3212 -7.0	2931 -8.0	2569 -8.9	2139 -9.5	1657 -9.9	1141 -10.0	613 -9.9	95 -9.6	-390 -9.1	75
70	3881 -1.4	3876 -2.7	3757 -3.9	3522 -5.0	3172 -6.0	2717 -6.9	2169 -7.6	1546 -8.2	874 -8.5	180 -8.5	-505 -8.3	-1147 -7.8	70
65	3998 .3	4005 -.5	3888 -1.3	3639 -2.1	3257 -2.9	2748 -3.8	2123 -4.6	1403 -5.3	615 -5.9	-207 -6.3	-1024 -6.4	-1795 -6.3	65
60	3884 1.4	3904 1.3	3798 1.1	3555 .9	3170 .5	2645 -.1	1988 -.8	1218 -1.7	363 -2.5	-539 -3.3	-1445 -4.0	-2304 -4.4	60
55	3583 1.4	3606 2.1	3512 2.8	3286 3.4	2920 3.7	2411 3.6	1763 3.2	991 2.4	122 1.3	-809 .1	-1753 -1.2	-2655 -2.4	55
50	3147 .5	3157 2.0	3067 3.7	2862 5.3	2530 6.5	2063 7.1	1461 7.0	733 6.4	-101 5.1	-1008 3.4	-1941 1.4	-2841 -.6	50
45	2628 -.9	2605 1.4	2509 4.1	2324 6.6	2036 8.6	1631 9.9	1105 10.3	459 9.7	-295 8.2	-1130 6.0	-2005 3.3	-2861 .4	45
40	2072 -1.8	2000 1.1	1886 4.4	1717 7.6	1477 10.3	1148 12.1	721 12.7	188 12.1	-448 10.1	-1172 7.3	-1950 3.7	-2726 .1	40
35	1519 -1.6	1383 1.6	1241 5.2	1087 8.7	891 11.7	646 13.5	332 14.1	-64 13.0	-553 10.5	-1134 6.8	-1784 2.4	-2453 -2.0	35
30	991 .0	783 3.1	605 6.5	453 9.8	308 12.5	150 14.1	-40 14.1	-265 12.4	-607 9.1	-1023 4.5	-1524 -.7	-2065 -5.6	30
25	495 2.8	213 5.3	-3 8.1	-151 10.8	-251 12.8	-320 13.7	-383 13.0	-468 10.5	-614 6.2	-853 .7	-1193 -5.2	-1596 -10.5	25
20	17 5.6	-334 7.3	-583 9.2	-728 11.0	-780 12.2	-760 12.3	-692 10.8	-615 7.4	-581 2.4	-643 -3.9	-820 -10.2	-1083 -15.6	20
15	-473 7.3	-882 8.1	-1157 9.1	-1290 10.0	-1290 10.5	-1177 9.9	-977 7.8	-739 3.9	-531 -1.6	-420 -8.2	-440 -14.7	-564 -19.8	15
10	-1016 6.8	-1469 6.7	-1758 7.0	-1869 7.5	-1810 7.6	-1598 6.8	-1265 4.6	-869 .6	-493 -4.8	-219 -11.2	-90 -17.4	-83 -22.2	10
5	-1656 3.4	-2138 2.8	-2428 3.0	-2507 3.5	-2380 3.9	-2064 3.4	-1597 1.6	-1047 -1.8	-512 -6.6	-83 -12.3	187 -17.8	321 -21.9	5
0	-2428 -2.8	-2927 -3.3	-3207 -2.7	-3245 -1.4	-3044 -.1	-2622 .3	-2022 .5	-1324 -2.8	-634 -6.5	-57 -11.0	352 -15.4	610 -18.7	0
LAT / E. LONG	60	65	70	75	80	85	90	95	100	105	110	115	LAT / E. LONG

EAST COMPONENT (Y) WMM-90

E. LONG / LAT	120	125	130	135	140	145	150	155	160	165	170	175	E. LONG / LAT
90	2172 -13.2	2171 -14.0	2153 -14.7	2120 -15.3	2070 -15.8	2004 -16.1	1923 -16.3	1827 -16.5	1718 -16.4	1595 -16.3	1460 -16.0	1314 -15.6	90
85	1174 -11.4	1061 -11.5	966 -11.6	892 -11.6	840 -11.6	812 -11.7	806 -11.7	823 -11.8	857 -11.8	907 -12.0	967 -12.1	1032 -12.2	85
80	160 -9.8	-74 -9.3	-254 -8.8	-372 -8.3	-424 -7.9	-408 -7.6	-326 -7.4	-187 -7.4	15 -7.6	258 -8.0	535 -8.6	832 -9.4	80
75	-821 -8.4	-1176 -7.5	-1439 -6.6	-1599 -5.8	-1645 -5.0	-1578 -4.4	-1400 -4.0	-1118 -4.0	-747 -4.2	-301 -4.9	198 -5.9	731 -7.3	75
70	-1716 -7.1	-2181 -6.2	-2518 -5.2	-2709 -4.2	-2742 -3.3	-2617 -2.6	-2337 -2.2	-1917 -2.1	-1375 -2.4	-735 -3.1	-26 -4.4	723 -6.2	70
65	-2476 -5.9	-3030 -5.3	-3423 -4.6	-3632 -3.8	-3642 -3.1	-3453 -2.5	-3074 -2.1	-2523 -2.1	-1828 -2.4	-1020 -3.2	-133 -4.4	796 -6.2	65
60	-3064 -4.7	-3678 -4.7	-4104 -4.6	-4313 -4.4	-4289 -4.1	-4036 -4.0	-3561 -3.9	-2897 -4.0	-2076 -4.4	-1137 -5.0	-120 -5.9	933 -7.4	60
55	-3456 -3.5	-4097 -4.3	-4530 -5.1	-4721 -5.7	-4654 -6.2	-4331 -6.7	-3775 -7.1	-3018 -7.5	-2103 -7.9	-1076 -8.3	19 -8.7	1138 -9.4	55
50	-3642 -2.6	-4279 -4.4	-4695 -6.0	-4851 -7.4	-4731 -8.7	-4343 -9.8	-3713 -10.8	-2885 -11.6	-1908 -12.1	-832 -12.3	292 -12.2	1422 -11.9	50
45	-3628 -2.4	-4231 -5.0	-4607 -7.2	-4714 -9.1	-4536 -10.9	-4084 -12.4	-3394 -13.8	-2515 -15.0	-1502 -15.8	-413 -16.0	702 -15.6	1797 -14.7	45
40	-3427 -3.4	-3972 -6.4	-4290 -8.7	-4336 -10.6	-4096 -12.2	-3586 -13.6	-2848 -15.1	-1936 -16.5	-912 -17.6	166 -18.3	1240 -18.1	2264 -17.2	40
35	-3064 -5.8	-3531 -8.7	-3776 -10.6	-3752 -11.7	-3448 -12.3	-2887 -12.9	-2114 -13.8	-1188 -15.1	-172 -16.8	872 -18.2	1883 -19.1	2811 -19.1	35
30	-2570 -9.5	-2944 -11.9	-3106 -12.7	-3006 -12.1	-2639 -11.0	-2033 -10.0	-1240 -9.8	-317 -10.8	672 -12.9	1664 -15.6	2594 -18.3	3407 -20.2	30
25	-1984 -14.1	-2256 -15.6	-2326 -14.8	-2148 -12.1	-1721 -8.6	-1080 -5.4	-279 -3.6	624 -3.9	1570 -6.4	2494 -10.6	3328 -15.5	4016 -20.1	25
20	-1349 -18.8	-1515 -19.2	-1492 -16.6	-1237 -11.7	-756 -5.7	-91 -.1	705 3.6	1576 4.2	2466 1.6	3311 -3.9	4042 -11.3	4600 -18.9	20
15	-711 -22.5	-772 -21.8	-659 -17.8	-334 -10.9	191 -2.8	870 4.9	1650 10.3	2479 12.0	3306 9.5	4069 3.0	4698 -6.2	5175 -16.6	15
10	-114 -24.3	-75 -22.9	121 -17.9	505 -10.0	1062 -.6	1743 8.4	2499 15.1	3283 17.8	4048 15.8	4735 9.1	5273 -1.3	5606 -13.5	10
5	401 -23.5	534 -21.8	802 -16.8	1234 -8.9	1810 .6	2485 9.9	3216 17.0	3956 20.5	4667 19.2	5290 15.1	5758 2.9	6017 -9.6	5
0	799 -20.0	1021 -18.6	1354 -14.3	1824 -7.5	2412 .8	3077 9.1	3781 15.9	4489 19.6	5159 19.2	5737 14.5	6159 5.8	6376 -5.5	0
LAT / E. LONG	120	125	130	135	140	145	150	155	160	165	170	175	LAT / E. LONG

EAST COMPONENT (Y) WMM-90

E. LONG / LAT	180	185	190	195	200	205	210	215	220	225	230	235	E. LONG / LAT
90	1158 -15.1	994 -14.5	821 -13.7	643 -12.9	459 -12.0	273 -10.9	84 -9.8	-106 -8.6	-295 -7.4	-481 -6.1	-664 -4.7	-842 -3.3	90
85	1096 -12.4	1154 -12.6	1199 -12.7	1226 -12.9	1230 -12.7	1207 -12.6	1153 -12.3	1065 -11.9	942 -11.4	783 -10.7	590 -9.8	365 -8.7	85
80	1136 -10.3	1452 -11.3	1706 -12.4	1947 -13.5	2141 -14.5	2278 -15.4	2351 -16.1	2354 -16.6	2282 -16.8	2136 -16.6	1915 -16.1	1623 -15.2	80
75	1273 -8.9	1804 -10.9	2300 -12.9	2743 -15.1	3113 -17.2	3397 -19.1	3582 -20.7	3660 -22.0	3626 -22.8	3480 -23.0	3223 -22.8	2862 -21.9	75
70	1483 -8.4	2222 -11.0	2913 -13.9	3531 -16.9	4052 -20.0	4459 -22.8	4737 -25.3	4876 -27.3	4872 -28.6	4723 -29.1	4434 -28.9	4011 -27.9	70
65	1728 -8.6	2632 -11.4	3476 -14.7	4229 -18.3	4866 -22.0	5368 -25.6	5718 -28.9	5907 -31.4	5929 -33.2	5783 -34.0	5475 -33.7	5012 -32.5	65
60	1983 -9.3	2996 -11.8	3936 -14.9	4776 -18.6	5489 -22.6	6054 -26.7	6455 -30.6	6682 -33.8	6730 -36.0	6599 -37.1	6293 -36.8	5819 -35.4	60
55	2243 -10.4	3300 -12.0	4278 -14.4	5149 -17.6	5891 -21.4	6484 -25.8	6912 -30.1	7165 -33.9	7239 -36.7	7134 -38.2	6853 -38.1	6402 -36.5	55
50	2521 -11.8	3559 -12.1	4512 -13.3	5359 -15.5	6092 -18.8	6664 -23.0	7093 -27.6	7359 -31.9	7456 -35.3	7386 -37.2	7149 -37.4	6747 -35.9	50
45	2838 -13.3	3801 -12.6	4672 -12.4	5439 -13.4	6096 -15.8	6631 -19.4	7036 -23.8	7299 -28.3	7416 -32.1	7383 -34.4	7201 -34.9	6867 -33.6	45
40	3206 -15.6	4049 -13.9	4789 -12.6	5432 -12.5	5982 -13.4	6440 -16.1	6798 -19.8	7047 -23.9	7176 -27.5	7179 -29.9	7052 -30.6	6791 -29.5	40
35	3624 -18.1	4313 -16.4	4888 -14.6	5373 -13.3	5789 -13.1	6148 -14.3	6446 -16.6	6670 -19.5	6803 -22.2	6834 -24.0	6757 -24.4	6565 -23.4	35
30	4072 -20.8	4587 -20.3	4979 -18.8	5290 -16.9	5560 -15.4	5812 -14.7	6043 -14.8	6235 -15.5	6363 -16.3	6412 -16.7	6371 -16.3	6236 -15.3	30
25	4524 -23.5	4861 -25.0	5067 -24.7	5207 -23.0	5335 -20.3	5482 -17.4	5645 -14.7	5799 -12.3	5914 -10.2	5966 -8.2	5948 -6.5	5856 -5.2	25
20	4956 -25.5	5123 -29.8	5161 -31.4	5147 -30.2	5149 -26.7	5202 -21.6	5301 -15.6	5414 -9.6	5503 -3.9	5546 1.0	5536 4.8	5476 6.4	20
15	5352 -26.3	5376 -33.5	5274 -37.3	5137 -37.0	5038 -32.9	5013 -25.9	5053 -16.8	5121 -7.0	5177 2.5	5199 10.5	5184 16.0	5145 18.4	15
10	5714 -25.4	5629 -35.0	5427 -40.6	5204 -41.4	5033 -37.2	4948 -28.7	4937 -17.1	4960 -4.0	4977 8.7	4969 19.5	4941 26.7	4910 29.4	10
5	6051 -22.4	5898 -33.3	5639 -40.2	5367 -41.9	5156 -38.0	5028 -28.8	4976 -15.7	4957 -.5	4936 14.5	4895 27.1	4846 35.4	4810 38.0	5
0	6376 -17.8	6198 -28.3	5922 -35.6	5638 -39.8	5406 -34.5	5258 -25.6	5172 -12.3	5125 3.2	5069 18.2	4998 32.4	4926 40.9	4867 43.2	0
LAT / E. LONG	180	185	190	195	200	205	210	215	220	225	230	235	LAT / E. LONG

EAST COMPONENT (Y) WMM-90

E. LONG / LAT	240	245	250	255	260	265	270	275	280	285	290	295	E. LONG / LAT
90	-1016 -1.9	-1177 -.5	-1332 1.0	-1477 2.4	-1610 3.8	-1731 5.2	-1839 6.5	-1933 7.8	-2012 9.1	-2076 10.2	-2124 11.3	-2156 12.3	90
85	111 -7.4	-169 -6.0	-468 -4.4	-781 -2.6	-1101 -.8	-1423 1.2	-1737 3.2	-2038 5.3	-2319 7.3	-2573 9.4	-2794 11.4	-2976 13.2	85
80	1271 -14.0	861 -12.4	406 -10.5	-87 -8.4	-600 -6.0	-1123 -3.3	-1642 -.6	-2144 2.2	-2616 5.2	-3045 8.1	-3422 10.9	-3737 13.7	80
75	2406 -20.6	1865 -18.7	1256 -16.5	590 -13.8	-111 -10.9	-828 -7.8	-1542 -4.5	-2236 -1.0	-2884 2.6	-3475 6.2	-3991 9.8	-4420 13.4	75
70	3465 -26.3	2810 -24.0	2063 -21.4	1244 -18.4	375 -15.1	-520 -11.7	-1615 -8.1	-2284 -4.3	-3100 -.4	-3840 3.7	-4486 7.9	-5012 12.1	70
65	4406 -30.5	3666 -27.8	2816 -24.8	1873 -21.5	864 -18.1	-185 -14.7	-1241 -11.3	-2272 -7.7	-3243 -3.9	-4123 .3	-4886 4.9	-5502 9.8	65
60	5187 -33.0	4408 -29.8	3497 -26.6	2472 -23.7	1359 -20.1	187 -17.1	-1007 -14.3	-2183 -11.3	-3297 -7.9	-4309 -3.9	-5181 .9	-5883 6.4	60
55	5785 -33.8	5010 -30.5	4085 -27.0	3023 -23.8	1848 -21.2	589 -19.1	-714 -17.3	-2013 -15.4	-3256 -12.8	-4391 -9.1	-5370 -4.2	-6156 1.9	55
50	6181 -33.1	5450 -29.7	4555 -26.4	3503 -23.7	2308 -22.3	1001 -21.1	-378 -20.7	-1774 -20.1	-3126 -18.6	-4373 -15.4	-5456 -10.4	-6326 -3.5	50
45	6376 -31.0	5720 -27.8	4890 -25.0	3884 -23.2	2711 -22.7	1396 -23.5	-21 -24.8	-1483 -25.8	-2921 -25.4	-4266 -22.8	-5446 -17.6	-6404 -9.8	45
40	6386 -27.3	5822 -24.7	5092 -22.8	4153 -22.4	3036 -23.7	1750 -26.4	332 -29.8	-1160 -32.5	-2657 -33.3	-4081 -31.2	-5352 -25.7	-6401 -17.1	40
35	6245 -21.8	5779 -20.2	5142 -19.8	4311 -21.3	3279 -24.8	2056 -29.9	670 -35.5	-821 -40.0	-2348 -42.1	-3830 -40.5	-5181 -34.8	-6324 -25.3	35
30	5995 -14.3	5626 -14.1	5099 -15.7	4382 -19.7	3455 -25.9	2318 -33.7	995 -41.7	-467 -48.2	-2001 -51.5	-3522 -50.4	-4944 -44.5	-6180 -34.[illegible]	30
25	5684 -4.9	5409 -6.5	4996 -10.6	4402 -17.5	3595 -26.8	2563 -37.6	1319 -48.1	-96 -56.5	-1619 -61.0	-3166 -60.5	-4648 -54.6	-5976 -43.8	25
20	5364 5.8	5179 2.2	4878 -4.8	4412 -14.6	3733 -27.5	2816 -41.2	1658 -54.2	298 -64.4	-1204 -70.1	-2769 -70.2	-4305 -64.4	-5722 -53.4	20
15	5083 16.8	4979 11.1	4786 1.2	4443 -12.3	3890 -28.1	3086 -44.5	2019 -59.6	717 -71.3	-763 -78.0	-2340 -78.7	-3926 -73.2	-5428 -62.3	15
10	4884 26.8	4845 19.0	4744 6.3	4512 -10.2	4075 -28.7	3379 -47.4	2400 -64.0	1156 -76.8	-300 -84.1	-1889 -85.3	-3519 -80.3	-5100 -69.9	10
5	4800 32.4	4821 24.7	4766 9.7	4620 -9.1	4282 -29.6	3683 -48.7	2789 -67.2	1604 -80.4	176 -88.1	-1419 -89.6	-3088 -85.1	-4736 -75.3	5
0	4649 38.5	4861 27.3	4857 10.7	4766 -9.4	4502 -30.9	3988 -51.4	3175 -69.0	2054 -82.0	663 -89.6	-928 -91.3	-2624 -87.3	-4324 -78.2	0
LAT / E. LONG	240	245	250	255	260	265	270	275	280	285	290	295	LAT / E. LONG

EAST COMPONENT (Y) WMM-90

E. LONG / LAT	300	305	310	315	320	325	330	335	340	345	350	355	E. LONG / LAT
90	-2172 13.2	-2171 14.0	-2153 14.7	-2120 15.3	-2070 15.8	-2004 16.1	-1923 16.3	-1827 16.5	-1718 16.4	-1595 16.3	-1460 16.0	-1314 15.6	90
85	-3117 14.9	-3212 16.5	-3258 17.9	-3255 19.0	-3203 20.0	-3102 20.6	-2956 21.0	-2762 21.2	-2529 21.1	-2262 20.7	-1963 20.0	-1640 19.2	85
80	-3983 16.2	-4156 18.6	-4247 20.7	-4263 22.5	-4197 23.9	-4057 24.9	-3846 25.5	-3569 25.7	-3233 25.5	-2848 24.9	-2417 24.0	-1955 22.7	80
75	-4752 16.8	-4980 20.0	-5102 22.9	-5117 25.4	-5028 27.4	-4842 28.9	-4566 29.8	-4210 30.1	-3785 29.8	-3302 29.0	-2773 27.7	-2209 26.0	75
70	-5415 16.4	-5683 20.5	-5815 24.3	-5815 27.5	-5689 30.4	-5448 32.5	-5105 33.8	-4673 34.3	-4168 34.0	-3607 33.0	-3002 31.4	-2368 29.2	70
65	-5963 14.9	-6259 20.1	-6390 25.0	-6363 29.4	-6190 33.0	-5888 35.8	-5475 37.6	-4971 38.3	-4396 38.0	-3768 36.8	-3106 34.9	-2424 32.3	65
60	-6398 12.4	-6715 18.7	-6837 24.9	-6777 30.5	-6553 35.2	-6188 38.8	-5709 41.0	-5138 42.0	-4501 41.8	-3818 40.5	-3110 38.4	-2395 35.5	60
55	-6723 9.0	-7061 16.7	-7175 24.2	-7083 31.1	-6811 36.9	-6389 41.2	-5850 44.1	-5222 45.4	-4532 45.3	-3802 44.1	-3055 41.9	-2312 38.9	55
50	-6951 4.8	-7317 13.9	-7431 22.9	-7315 31.2	-7004 38.0	-6536 43.1	-5949 46.4	-5275 48.1	-4540 48.3	-3770 47.4	-2986 45.5	-2214 42.7	50
45	-7092 -.2	-7506 10.4	-7636 21.0	-7513 30.5	-7178 38.4	-6678 44.2	-6055 48.1	-5345 50.2	-4573 50.9	-3765 50.5	-2945 49.1	-2141 46.8	45
40	-7175 -6.1	-7646 6.1	-7816 18.1	-7710 29.0	-7375 37.9	-6861 44.5	-6216 49.0	-5478 51.9	-4673 53.0	-3826 53.4	-2964 52.7	-2123 51.1	40
35	-7193 -13.0	-7751 .7	-7992 14.2	-7937 26.4	-7630 36.3	-7126 43.8	-6473 49.1	-5711 52.6	-4871 54.9	-3980 56.1	-3070 56.3	-2186 55.3	35
30	-7157 -20.6	-7828 -5.8	-8171 9.1	-8207 22.5	-7964 33.7	-7495 42.5	-6848 48.7	-6067 53.2	-5187 56.4	-4262 58.6	-3277 59.6	-2343 59.2	30
25	-7071 -29.5	-7876 -13.4	-8359 2.7	-8517 17.5	-8373 30.0	-7965 39.9	-7340 47.8	-6542 53.5	-5618 57.8	-4614 60.9	-3587 62.6	-2600 62.5	25
20	-6840 -38.6	-7892 -21.7	-8536 -4.6	-8845 11.4	-8826 25.3	-8501 36.9	-7810 46.9	-7102 53.3	-6136 58.9	-5074 62.8	-3989 65.0	-2856 65.1	20
15	-6766 -47.4	-7867 -30.2	-8674 -12.3	-9146 4.7	-9265 20.1	-9036 33.2	-8489 44.0	-7682 52.8	-6688 59.5	-5585 64.2	-4461 66.7	-3398 66.9	15
10	-6547 -55.3	-7724 -38.1	-8762 -19.6	-9366 -2.0	-9612 14.5	-9477 29.1	-8987 41.5	-8202 51.6	-7206 59.4	-6097 64.7	-4969 67.6	-3908 67.8	10
5	-6275 -61.4	-7621 -44.6	-8699 -26.5	-9440 -8.2	-9794 9.2	-9748 24.8	-9320 38.5	-8582 49.8	-7626 58.4	-6557 64.4	-5471 67.6	-4447 68.3	5
0	-5930 -65.9	-7354 -49.2	-8511 -31.5	-9330 -13.9	-9761 4.5	-9785 21.0	-9432 35.4	-8770 47.4	-7898 56.7	-6918 63.2	-5923 67.0	-4975 68.1	0
LAT / E. LONG	300	305	310	315	320	325	330	335	340	345	350	355	LAT / E. LONG

EAST COMPONENT (Y) WMM-90

E. LONG / LAT	0	5	10	15	20	25	30	35	40	45	50	55	E. LONG / LAT
0	-4113 67.0	-3338 63.9	-2630 59.2	-1963 53.7	-1323 46.2	-739 38.5	-281 30.4	-45 22.5	-105 15.0	-470 8.4	-1062 3.3	-1770 -.7	0
-5	-4643 67.3	-3893 65.0	-3167 61.0	-2455 55.3	-1771 48.1	-1170 39.5	-741 29.9	-578 23.0	-740 13.4	-1212 1.9	-1902 -4.7	-2666 -9.1	-5
-10	-5059 66.9	-4345 65.3	-3620 61.6	-2893 55.8	-2205 47.8	-1636 37.8	-1284 26.4	-1238 14.4	-1533 2.8	-2129 -7.1	-2914 -14.5	-3736 -18.7	-10
-15	-5307 65.7	-4641 64.0	-3945 60.0	-3247 53.4	-2611 44.2	-2133 32.6	-1915 19.4	-2029 5.6	-2485 -7.2	-3218 -17.7	-4097 -24.8	-4967 -27.9	-15
-20	-5367 63.2	-4765 60.6	-4136 55.5	-3517 47.5	-2996 36.8	-2671 23.6	-2637 9.0	-2946 -5.7	-3581 -18.7	-4451 -28.6	-5415 -34.3	-6322 -35.4	-20
-25	-5269 59.2	-4751 54.9	-4223 47.9	-3741 38.1	-3392 25.6	-3271 11.2	-3658 -4.0	-3975 -18.5	-4786 -30.5	-5782 -38.5	-6819 -41.7	-7744 -39.9	-25
-30	-5078 53.6	-4671 47.0	-4286 37.6	-3984 25.7	-3847 11.8	-3958 -3.3	-4371 -18.2	-5091 -31.4	-6057 -41.2	-7151 -46.3	-8232 -46.3	-9167 -41.4	-30
-35	-4883 46.9	-4618 37.5	-4410 25.8	-4318 12.0	-4411 -3.0	-4753 -18.0	-5376 -31.8	-6263 -42.7	-7342 -49.5	-8498 -51.4	-9598 -48.0	-10526 -40.1	-35
-40	-4764 39.4	-4679 27.7	-4662 13.6	-4790 -1.1	-5108 -16.4	-5657 -30.7	-6449 -42.7	-7455 -51.0	-8598 -54.7	-9774 -53.4	-10869 -47.1	-11772 -37.0	-40
-45	-4769 31.9	-4867 15.6	-5067 3.7	-5409 -11.8	-5927 -26.6	-6646 -38.6	-7557 -49.5	-8629 -55.2	-9789 -56.3	-10947 -52.5	-12005 -44.5	-12879 -33.3	-45
-50	-4905 24.8	-5203 11.2	-5606 -3.7	-6149 -18.5	-6825 -32.1	-7667 -43.4	-8654 -51.3	-9748 -55.0	-10888 -54.5	-12000 -49.5	-13007 -40.8	-13839 -30.0	-50
-55	-5145 18.6	-5638 5.9	-6277 -7.7	-6925 -21.0	-7740 -32.8	-8669 -42.2	-9693 -48.3	-10779 -50.7	-11876 -49.3	-12926 -44.4	-13870 -36.7	-14651 -27.5	-55
-60	-5447 13.3	-6123 2.5	-6873 -8.9	-7705 -19.9	-8617 -29.4	-9601 -36.9	-10638 -41.7	-11696 -43.5	-12738 -42.3	-13719 -38.5	-14592 -32.7	-15313 -25.9	-60
-65	-5775 8.7	-6613 .5	-7500 -8.1	-8437 -16.4	-9419 -23.7	-10434 -29.4	-11465 -33.2	-12485 -34.9	-13465 -34.6	-14371 -32.4	-15168 -28.9	-15821 -24.7	-65
-70	-6106 4.7	-7085 -.9	-8084 -6.8	-9102 -12.6	-10139 -17.7	-11158 -21.9	-12168 -25.0	-13141 -26.8	-14053 -27.3	-14879 -26.8	-15592 -25.4	-16168 -23.5	-70
-75	-6439 .9	-7533 -2.6	-8621 -6.2	-9697 -9.9	-10751 -13.3	-11774 -16.2	-12751 -18.6	-13667 -20.4	-14503 -21.5	-15243 -22.1	-15869 -22.1	-16357 -21.8	-75
-80	-6777 -2.8	-7959 -4.9	-9108 -7.0	-10218 -9.1	-11279 -11.2	-12281 -13.2	-13213 -14.9	-14064 -16.4	-14829 -17.6	-15470 -18.5	-16001 -19.2	-16402 -19.6	-80
-85	-7128 -6.3	-8359 -7.6	-9537 -8.9	-10654 -10.2	-11700 -11.5	-12667 -12.7	-13545 -13.8	-14326 -14.9	-15003 -15.6	-15566 -16.3	-16013 -16.9	-16328 -17.3	-85
-90	-7469 -9.2	-8723 -10.2	-9889 -11.2	-10981 -12.1	-11990 -12.8	-12927 -13.5	-13726 -14.1	-14440 -14.8	-15046 -15.0	-15534 -15.2	-15906 -15.4	-16157 -15.4	-90
LAT / E. LONG	0	5	10	15	20	25	30	35	40	45	50	55	LAT / E. LONG

EAST COMPONENT (Y) WMM-90

E. LONG / LAT	60	65	70	75	80	85	90	95	100	105	110	115	LAT / E. LONG
0	-2428 -2.8	-2927 -3.3	-3207 -2.7	-3245 -1.4	-3044 -.1	-2622 .3	-2022 -.5	-1324 -2.8	-636 -6.5	-57 -11.0	352 -15.4	610 -18.7	0
-5	-3357 -11.0	-3862 -10.7	-4121 -8.8	-4117 -6.1	-3832 -3.5	-3312 -1.6	-2586 -1.1	-1746 -2.1	-908 -4.4	-183 -7.5	367 -10.7	755 -13.2	-5
-10	-4449 -19.6	-4949 -17.8	-5181 -14.1	-5123 -9.6	-4776 -5.3	-4157 -1.9	-3317 -.1	-2746 .2	-1366 -.7	-492 -2.5	[illegible] -.5	733 -6.2	-10
-15	-5690 -27.1	-6175 -23.2	-6372 -17.3	-6265 -10.8	-5855 -4.9	-5156 -.3	-4218 2.5	-3132 3.7	-2019 3.7	-998 2.9	-144 1.8	535 .7	-15
-20	-7044 -32.1	-7503 -25.7	-7662 -17.6	-7508 -9.3	-7043 -2.2	-6281 3.1	-5267 6.2	-4086 7.7	-2855 7.9	-1693 7.5	-681 7.0	160 6.4	-20
-25	-8455 -33.9	-8883 -24.9	-9003 -14.8	-8807 -5.3	-8299 2.3	-7491 7.5	-6422 10.2	-5171 11.1	-3844 10.9	-2555 10.4	-1389 10.0	-380 9.7	-25
-30	-9860 -32.5	-10257 -21.4	-10342 -10.0	-10113 .0	-9574 7.5	-8738 11.8	-7638 13.5	-6342 13.3	-4944 12.1	-3548 11.0	-2242 10.3	-1067 10.1	-30
-35	-11198 -28.9	-11570 -16.4	-11631 -4.4	-11382 5.4	-10827 11.9	-9980 15.0	-8870 15.1	-7553 13.4	-6111 11.0	-4635 9.0	-3207 8.0	-1878 8.0	-35
-40	-12423 -24.5	-12779 -11.5	-12830 .2	-12576 9.0	-12022 14.2	-11181 15.8	-10080 14.5	-8764 11.4	-7302 7.9	-5772 5.1	-4248 3.7	-2784 3.9	-40
-45	-13508 -20.6	-13857 -8.2	-13910 2.4	-13665 9.8	-13128 13.6	-12310 13.9	-11234 11.4	-9938 7.4	-8478 3.2	-6920 .0	-5329 -1.5	-3758 -1.0	-45
-50	-14443 -18.3	-14786 -7.3	-14849 1.5	-14626 7.4	-14118 9.8	-13335 9.2	-12298 6.2	-11038 2.0	-9600 -2.2	-8040 -5.3	-6413 -6.5	-4771 -5.7	-50
-55	-15224 -17.8	-15557 -9.1	-15629 -2.2	-15430 2.1	-14958 3.6	-14221 2.5	-13233 -.3	-12024 -4.0	-10629 -7.4	-9093 -9.8	-7465 -10.5	-5793 -9.2	-55
-60	-15846 -18.8	-16159 -12.5	-16233 -7.7	-16054 -4.9	-15618 -3.9	-14929 -4.7	-14002 -6.8	-12857 -9.4	-11525 -11.7	-10042 -13.1	-8451 -12.9	-6791 -11.2	-60
-65	-16301 -20.3	-16581 -16.4	-16643 -13.4	-16475 -11.5	-16070 -10.9	-15432 -11.3	-14571 -12.4	-13503 -13.6	-12254 -14.5	-10852 -14.7	-9333 -13.8	-7731 -11.7	-65
-70	-16582 -21.3	-16816 -19.4	-16856 -17.8	-16685 -16.7	-16305 -16.1	-15715 -15.9	-14923 -16.0	-13942 -16.1	-12791 -15.8	-11493 -15.0	-10075 -13.5	-8567 -11.2	-70
-75	-16697 -21.2	-16874 -20.5	-16876 -19.8	-16696 -19.2	-16332 -18.6	-15785 -18.1	-15060 -17.4	-14168 -16.7	-13123 -15.6	-11941 -14.2	-10644 -12.4	-9253 -10.2	-75
-80	-16664 -19.7	-16778 -19.7	-16738 -19.4	-16541 -19.0	-16185 -18.5	-15672 -17.7	-15007 -16.8	-14197 -15.7	-13252 -14.4	-12184 -12.9	-11008 -11.1	-9738 -9.2	-80
-85	-16516 -17.5	-16570 -17.5	-16487 -17.3	-16267 -17.0	-15911 -16.4	-15420 -15.7	-14799 -14.8	-14054 -13.8	-13190 -12.6	-12217 -11.3	-11144 -9.8	-9981 -8.3	-85
-90	-16285 -15.3	-16288 -15.1	-16168 -14.8	-15925 -14.3	-15561 -13.8	-15078 -13.1	-14480 -12.4	-13773 -11.5	-12960 -10.6	-12049 -9.6	-11046 -8.5	-9959 -7.4	-90
LAT / E. LONG	60	65	70	75	80	85	90	95	100	105	110	115	LAT / E. LONG

EAST COMPONENT (Y) WMM-90

E. LONG / LAT	120	125	130	135	140	145	150	155	160	165	170	175	E. LONG / LAT
0	799 -20.0	1021 -18.6	1354 -14.3	1824 -7.5	2412 .8	3077 9.1	3781 15.9	4489 19.6	5159 19.2	5737 14.5	6159 5.8	6376 -5.5	0
-5	1056 -14.3	1366 -13.5	1760 -10.6	2264 -5.8	2863 .2	3522 6.6	4210 12.1	4894 15.7	5539 16.3	6092 13.5	6494 7.3	6699 -1.5	-5
-10	1155 -7.2	1559 -7.2	2018 -6.1	2560 -3.8	3176 -.5	3840 3.3	4523 7.0	5199 10.0	5833 11.4	6377 10.7	6779 7.5	6999 2.2	-10
-15	1090 -.2	1603 -.9	2136 -1.4	2729 -1.4	3376 -.9	4058 .3	4752 2.1	5433 4.2	6068 6.1	6617 7.3	7033 7.0	7284 5.1	-15
-20	866 5.6	1503 4.5	2133 3.0	2792 1.3	3487 -.3	4204 -1.3	4923 -1.2	5620 -.1	6266 2.0	6827 4.4	7265 6.3	7554 7.1	-20
-25	490 9.2	1271 8.2	2018 6.4	2766 4.0	3527 1.4	4295 -.8	5051 -2.0	5774 -1.7	6438 .1	7015 2.9	7478 5.9	7806 8.3	-25
-30	-25 10.1	917 9.7	1802 8.6	2660 6.6	3507 4.1	4340 1.7	5143 .1	5898 -.2	6585 1.0	7182 3.4	7669 6.2	8034 8.7	-30
-35	-664 8.6	449 9.3	1487 9.4	2475 9.8	3424 7.4	4336 5.8	5194 4.4	5989 3.8	6703 4.3	7321 5.6	7833 7.3	8230 8.6	-35
-40	-1410 5.2	-123 7.2	1070 9.0	2198 10.3	3261 10.7	4260 10.5	5186 9.9	6028 9.3	6776 9.0	7421 8.9	7958 8.8	8385 8.3	-40
-45	-2246 1.1	-811 4.2	540 7.7	1808 10.8	2992 13.2	4088 14.8	5089 15.0	5989 14.7	6780 15.9	7461 12.5	8030 10.5	8491 8.0	-45
-50	-3156 -2.9	-1597 1.2	-113 5.9	1284 10.5	2583 14.4	3779 17.1	4866 18.6	5832 18.7	6681 17.6	7612 15.5	8027 12.0	8535 7.9	-50
-55	-4118 -6.0	-2475 -1.4	-894 3.9	605 9.[illegible]	2006 14.1	3297 17.7	4469 19.9	5517 20.5	6440 19.4	7240 16.8	7926 13.0	8501 8.3	-55
-60	-5105 -7.8	-3429 -3.2	-1795 2.0	-228 7.5	1249 12.4	2622 16.3	3880 18.8	5016 19.8	6028 19.1	6921 16.8	7700 13.3	8376 8.9	-60
-65	-6082 -8.4	-4423 -4.3	-2783 .5	-1190 5.3	334 9.5	1769 13.4	3103 15.9	4330 17.2	5444 17.0	6449 15.6	7349 13.1	8153 9.8	-65
-70	-6999 -8.2	-5399 -4.7	-3797 -.8	-2216 3.1	-680 6.7	793 9.8	2191 12.2	3502 13.6	4723 14.1	5851 13.6	6887 12.4	7838 10.6	-70
-75	-7791 -7.7	-6282 -4.8	-4749 -1.8	-3213 1.1	-1692 4.0	-205 6.5	1235 8.5	2618 10.0	3935 11.0	5181 11.5	6353 11.5	7451 11.1	-75
-80	-8392 -7.1	-6987 -4.9	-5539 -2.6	-4066 -.4	-2583 1.8	-1105 3.8	355 5.6	1785 7.1	3174 8.5	4515 9.5	5800 10.4	7024 11.0	-80
-85	-8740 -6.7	-7633 -5.0	-6071 -3.2	-4668 -1.5	-3237 .2	-1789 1.9	-337 3.5	1108 5.0	2534 6.4	3939 7.7	5282 8.6	6598 10.0	-85
-90	-8796 -6.1	-7566 -4.9	-6279 -3.6	-4944 -2.3	-3571 -.9	-2171 .4	-755 1.7	667 3.1	2085 4.4	3486 5.8	4861 6.9	6198 8.0	-90
LAT / E. LONG	120	125	130	135	140	145	150	155	160	165	170	175	LAT / E. LONG

EAST COMPONENT (Y) WMM-90

E. LONG / LAT	180	185	190	195	200	205	210	215	220	225	230	235	E. LONG / LAT
0	6376 -17.6	6198 -28.3	5922 -35.6	5636 -38.0	5406 -34.5	5258 -25.6	5177 -12.3	5125 3.5	5069 19.2	4998 32.4	4922 40.9	4867 43.2	0
-5	6700 -11.4	6535 -20.7	6275 -27.4	6003 -30.0	5779 -27.4	5624 -19.5	5526 -7.3	5451 7.5	5371 22.4	5272 34.9	5168 42.7	5083 44.1	-5
-10	7030 -4.7	6905 -11.6	6688 -17.1	6450 -19.8	6246 -17.9	6096 -11.8	5992 -1.8	5904 10.7	5808 23.5	5690 34.2	5561 40.6	5443 41.2	-10
-15	7362 1.6	7295 -2.6	7137 -6.5	6947 -8.8	6772 -8.3	6635 -4.3	6531 2.9	6438 12.3	6335 22.3	6209 30.6	6065 35.4	5922 35.2	-15
-20	7688 6.5	7687 4.6	7594 2.1	7457 .0	7317 -.5	7197 1.3	7097 5.6	7006 11.8	6906 18.8	6785 24.9	6644 28.3	6497 27.8	-20
-25	7996 9.4	8061 8.9	8033 7.3	7949 5.2	7845 3.6	7745 3.6	7656 5.4	7574 9.1	7488 13.7	7388 18.1	7274 20.8	7150 20.7	-25
-30	8274 10.1	8398 10.0	8430 8.4	8397 6.0	8332 3.7	8256 2.3	8186 2.5	8124 4.5	8068 7.8	8010 11.4	7946 14.3	7875 15.3	-30
-35	8512 9.0	8687 8.1	8772 6.0	8789 3.1	8766 .2	8726 -1.8	8688 -2.3	8663 -.9	8654 2.1	8656 6.0	8663 9.8	8665 12.4	-35
-40	8705 6.9	8925 4.6	9059 1.4	9128 -2.1	9155 -5.2	9165 -7.3	9178 -7.5	9209 -5.8	9264 -2.2	9341 2.7	9429 7.8	9513 12.2	-40
-45	8849 4.7	9115 .8	9303 -3.4	9430 -7.4	9521 -10.5	9597 -12.0	9680 -11.6	9784 -9.0	9917 -4.4	10075 1.6	10245 8.1	10406 14.0	-45
-50	8944 3.2	9266 -1.8	9519 -6.7	9719 -10.8	9889 -13.5	10049 -14.5	10217 -13.2	10407 -9.7	10623 -4.2	10858 2.6	11096 9.9	11320 16.6	-50
-55	8983 3.0	9385 -2.4	9773 -7.2	10016 -11.0	10283 -13.3	10540 -13.8	10804 -11.7	11082 -7.6	11375 -1.8	11676 5.1	11966 12.3	12222 19.0	-55
-60	8961 4.1	9471 -.7	9920 -4.9	10327 -8.0	10706 -9.6	11071 -9.4	11433 -7.3	11794 -3.4	12153 2.0	12499 8.1	12816 14.4	13080 20.2	-60
-65	8871 6.2	9516 2.6	10101 -.4	10639 -2.2	11142 -3.5	11618 -3.0	12073 -1.1	12507 2.1	12916 6.3	13289 11.0	13610 15.7	13861 19.9	-65
-70	8708 8.6	9507 6.6	10242 4.9	10921 3.8	11551 3.4	12136 4.0	12677 5.3	13173 7.5	13617 10.2	14001 13.1	14313 16.0	14539 18.4	-70
-75	8475 10.6	9429 10.0	10313 9.5	11130 9.2	11881 9.3	12567 9.7	13186 10.6	13735 11.7	14208 13.0	14600 14.3	14900 15.6	15102 16.5	-75
-80	8182 11.5	9270 11.9	10285 12.2	11224 12.5	12083 12.8	12859 13.2	13549 13.6	14148 14.1	14653 14.5	15058 14.8	15359 15.0	15551 15.0	-80
-85	7846 11.0	9032 11.9	10144 12.6	11176 13.3	12122 13.8	12975 14.2	13731 14.6	14385 14.8	14932 14.9	15368 14.9	15691 14.8	15899 14.6	-85
-90	7489 9.2	8722 10.2	9889 11.2	10981 12.1	11990 12.8	12907 13.5	13726 14.1	14440 14.6	15044 15.0	15536 15.2	15906 15.4	16157 15.4	-90
LAT / E. LONG	180	185	190	195	200	205	210	215	220	225	230	235	LAT / E. LONG

EAST COMPONENT (Y) WMM-90

E. LONG / LAT	240	245	250	255	260	265	270	275	280	285	290	295	E. LONG / LAT
0	4849 38.5	4861 27.3	4857 10.7	4766 -9.4	4502 -30.9	3988 -51.4	3175 -69.0	2054 -83.0	663 -89.6	-928 -91.3	-2624 -87.3	-4324 -78.2	0
-5	5037 38.7	5029 26.7	5023 9.5	4955 -10.9	4741 -32.2	4296 -52.3	3560 -69.1	2508 -81.4	1163 -88.5	-409 -90.2	-2115 -86.6	-3847 -78.4	-5
-10	5358 35.2	5311 23.2	5279 6.5	5208 -13.1	5019 -33.2	4626 -51.9	3958 -67.4	2977 -78.7	1689 -85.1	149 -86.6	-1549 -83.5	-3291 -76.1	-10
-15	5802 29.4	5715 18.2	5648 2.8	5557 -14.9	5374 -33.1	5016 -49.8	4400 -63.7	3482 -73.8	2252 -79.7	756 -81.1	-918 -78.4	-2652 -71.8	-15
-20	6361 22.7	6249 13.2	6153 .0	6038 -15.2	5846 -31.0	5497 -45.7	4916 -58.0	4045 -67.1	2868 -72.6	1417 -74.2	-224 -72.1	-1938 -66.3	-20
-25	7029 17.0	6918 9.7	6809 -.8	6674 -13.3	6463 -26.6	6107 -39.3	5533 -50.4	4686 -58.9	3543 -64.4	2132 -66.5	527 -65.1	-1162 -60.2	-25
-30	7798 13.5	7713 8.8	7612 1.2	7465 -8.6	7231 -19.6	6849 -30.8	6258 -41.1	5408 -49.6	4281 -55.6	2896 -58.5	1326 -58.0	-339 -54.0	-30
-35	8653 12.9	8616 10.7	8536 5.8	8385 -1.6	8124 -10.8	7705 -20.9	7078 -30.9	6205 -39.7	5073 -48.5	3704 -50.4	2156 -51.0	523 -47.9	-35
-40	9575 14.3	9592 14.9	9539 12.2	9385 6.6	9097 -1.2	8635 -10.6	7963 -20.5	7056 -29.8	5909 -37.4	4547 -42.4	3025 -44.1	1425 -42.0	-40
-45	10533 18.2	10596 20.0	10564 18.8	10406 14.7	10090 7.8	9586 -1.0	8871 -10.9	7931 -20.5	6772 -28.8	5420 -34.6	3929 -37.2	2372 -36.0	-45
-50	11492 21.8	11583 24.5	11559 24.3	11389 21.0	11046 14.9	10508 6.6	9759 -2.8	8799 -12.4	7640 -20.8	6314 -27.1	4868 -30.2	3367 -29.7	-50
-55	12414 24.1	12509 27.0	12477 27.2	12289 24.4	11919 19.1	11357 11.7	10593 3.0	9634 -5.8	8497 -13.8	7215 -19.8	5832 -23.1	4403 -23.2	-55
-60	13265 24.5	13343 27.0	13286 27.1	13072 24.8	12682 20.2	12109 13.9	11350 6.6	10415 -.9	9324 -7.8	8108 -13.1	6806 -16.1	5461 -16.6	-60
-65	14019 23.0	14064 24.5	13974 24.4	13733 22.4	13330 18.8	12759 13.9	12023 8.2	11135 2.4	10109 -2.9	8975 -7.0	7763 -9.5	6509 -10.1	-65
-70	14662 20.1	14669 20.7	14547 20.3	14284 18.6	13875 16.0	13319 12.5	12620 8.6	11788 4.6	10839 1.0	9793 -1.9	8673 -3.7	7503 -4.3	-70
-75	15195 17.0	15171 16.9	15074 16.3	14750 15.0	14345 13.2	13812 11.0	13155 8.6	12382 6.2	11535 4.0	10538 2.2	9496 .9	8396 .4	-75
-80	15630 14.8	15593 14.4	15438 13.7	15167 12.7	14770 11.8	14262 10.3	13642 9.0	12916 7.7	12093 6.4	11182 5.3	10192 4.4	9135 3.8	-80
-85	15989 14.2	15961 13.8	15815 13.2	15552 12.6	15174 11.9	14684 11.1	14086 10.3	13385 9.4	12586 8.5	11695 7.7	10721 6.8	9669 6.0	-85
-90	16285 15.3	16283 15.1	16168 14.8	15925 14.3	15561 13.8	15078 13.1	14480 12.4	13773 11.6	12960 10.6	12049 9.6	11046 8.5	9959 7.4	-90
LAT / E. LONG	240	245	250	255	260	265	270	275	280	285	290	295	LAT / E. LONG

EAST COMPONENT (Y) WMM-90

E. LONG / LAT	300	305	310	315	320	325	330	335	340	345	350	355	LAT / E. LONG
0	-5930 -65.1	-7354 -49.2	-8511 -31.5	-9330 -13.4	-9761 4.5	-9785 21.0	-9432 35.4	-8770 47.4	-7898 56.7	-6918 61.2	-5922 67.0	-4975 68.1	0
-5	-5495 -66.4	-6962 -51.4	-8160 -34.5	-9021 -16.7	-9498 1.0	-9584 17.7	-9311 32.5	-8751 44.9	-7998 54.6	-7148 61.5	-6277 65.8	-5636 67.6	-5
-10	-6958 -65.1	-6442 -51.2	-7654 -35.2	-8530 -18.1	-9037 -.9	-9177 15.6	-8989 30.3	-8544 47.8	-7930 52.6	-7227 59.7	-6497 64.3	-5773 66.7	-10
-15	-4320 -61.8	-5805 -49.0	-7019 -34.0	-7902 -17.6	-8432 -1.0	-8624 15.0	-8521 29.3	-8192 41.5	-7713 51.1	-7152 58.2	-6556 62.8	-5941 65.3	-15
-20	-3596 -57.2	-5078 -45.2	-6293 -31.0	-7188 -15.4	-7747 .6	-7990 15.9	-7965 29.8	-7739 41.5	-7377 50.7	-6935 57.3	-6448 61.5	-5927 63.4	-20
-25	-2806 -51.9	-4286 -40.6	-5511 -27.1	-6427 -12.0	-7022 3.5	-7318 18.4	-7364 31.7	-7220 42.8	-6948 51.3	-6596 57.0	-6194 60.2	-5751 60.9	-25
-30	-1967 -46.4	-3447 -35.7	-4687 -22.6	-5633 -7.9	-6270 7.3	-6620 21.8	-6724 34.7	-6654 45.1	-6453 52.7	-6171 57.2	-5839 58.8	-5472 57.6	-30
-35	-1085 -41.1	-2561 -30.9	-3815 -18.1	-4793 -3.7	-5477 11.3	-5884 25.5	-6055 37.9	-6045 47.6	-5911 54.1	-5699 57.2	-5444 56.9	-5166 53.4	-35
-40	-155 -35.9	-1617 -28.4	-2878 -14.0	-3884 .1	-4616 14.7	-5085 28.5	-5328 40.4	-5396 49.3	-5345 54.7	-5222 56.3	-5066 54.2	-4905 48.4	-40
-45	833 -30.8	-601 -22.1	-1857 -10.4	-2886 3.0	-3668 18.9	-4209 30.0	-4542 41.1	-4713 49.2	-4776 53.5	-4773 53.8	-4751 50.1	-4740 42.6	-45
-50	1884 -25.5	491 -17.8	-751 -7.4	-1798 4.9	-2633 17.6	-3260 29.8	-3705 39.5	-4008 46.6	-4215 49.9	-4371 49.2	-4517 44.6	-4685 36.2	-50
-55	2988 -20.0	1646 -13.8	426 -4.7	-641 5.8	-1535 16.7	-2261 27.0	-2839 35.5	-3299 41.3	-3681 43.8	-4023 42.6	-4361 37.7	-4726 29.5	-55
-60	4122 -14.3	2833 -9.4	1632 -2.4	545 5.8	-415 14.5	-1250 22.7	-1973 29.4	-2607 33.9	-3181 35.6	-3724 34.2	-4267 29.8	-4834 22.6	-60
-65	5246 -8.7	4008 -5.3	2823 -.5	1709 5.4	678 11.6	-270 17.4	-1142 22.1	-1954 25.2	-2723 26.2	-3470 25.0	-4216 21.5	-4980 15.9	-65
-70	6309 -3.6	5114 -1.7	3936 1.2	2791 4.7	1687 8.4	628 11.9	-389 14.8	-1370 16.5	-2326 17.0	-3266 15.9	-4204 13.4	-5148 9.6	-70
-75	7255 .5	6087 1.2	4906 2.4	3724 4.0	2549 5.7	1386 7.2	237 8.4	-897 9.0	-2020 8.9	-3132 8.0	-4238 6.3	-5340 3.9	-75
-80	8021 3.4	6860 3.2	5662 3.2	4438 3.4	3196 3.5	1938 3.6	675 3.5	-588 3.2	-1848 2.7	-3101 1.9	-4344 .5	-5570 -1.0	-80
-85	8549 5.2	7369 4.4	6137 3.6	4861 2.8	3552 2.0	2216 1.2	864 .3	-497 -.6	-1858 -1.6	-3210 -2.7	-4545 -3.8	-5854 -5.0	-85
-90	8796 6.1	7568 4.9	6279 3.6	4944 2.3	3571 .9	2171 -.4	755 -1.7	-667 -3.1	-2085 -4.4	-3486 -5.6	-4860 -6.9	-6198 -8.0	-90
LAT / E. LONG	300	305	310	315	320	325	330	335	340	345	350	355	LAT / E. LONG

VERTICAL COMPONENT (Z) WMM-90

E. LONG	0	5	10	15	20	25	30	35	40	45	50	55	E. LONG
LAT													LAT
90	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	90
85	55294 -12.5	55318 -12.5	55356 -12.7	55407 -12.9	55471 -13.1	55546 -13.5	55632 -13.9	55728 -14.4	55833 -14.9	55944 -15.5	56060 -16.2	56160 -16.9	85
80	53989 -2.2	54021 -2.0	54088 -2.1	54190 -2.3	54326 -2.7	54494 -3.3	54692 -4.0	54918 -4.9	55167 -5.9	55437 -7.1	55723 -8.3	56018 -9.7	80
75	52607 7.1	52631 7.5	52712 7.7	52852 7.6	53048 7.2	53299 6.5	53603 5.6	53956 4.5	54354 3.3	54790 1.9	55258 .3	55750 -1.4	75
70	51182 13.8	51192 14.7	51278 15.1	51442 15.1	51680 14.7	51992 14.0	52375 13.1	52828 12.0	53345 10.7	53921 9.3	54549 7.8	55217 6.2	70
65	49661 17.8	49668 19.1	49764 19.8	49946 19.9	50212 19.6	50562 18.8	50994 17.9	51507 16.7	52100 15.4	52770 14.1	53506 12.9	54307 11.6	65
60	47930 19.5	47956 21.4	48078 22.5	48267 22.8	48581 22.5	48956 21.8	49414 20.6	49955 19.3	50581 17.8	51292 16.4	52086 15.1	52953 14.0	60
55	45845 19.7	45919 22.5	46090 24.2	46346 25.1	46678 25.0	47082 24.3	47557 22.8	48107 21.0	48736 19.0	49449 16.9	50246 15.1	51121 13.6	55
50	43272 18.7	43416 22.7	43659 25.6	43982 27.4	44370 28.0	44812 27.3	45310 25.7	45866 23.2	46487 20.1	47179 16.9	47942 13.9	48776 11.3	50
45	40096 16.2	40321 22.0	40650 26.6	41053 29.8	41507 31.3	41999 31.1	42528 29.2	43097 25.9	43713 21.7	44379 17.0	45093 12.4	45854 8.3	45
40	36222 11.6	36527 19.6	36938 26.3	37417 31.2	37933 34.0	38474 34.5	39039 32.6	39633 28.6	40257 23.3	40907 17.2	41574 11.1	42251 5.6	40
35	31570 4.6	31936 14.8	32410 23.7	32944 30.5	33503 34.6	34078 35.8	34675 34.0	35301 29.8	35952 23.9	36608 17.1	37246 10.2	37846 4.1	35
30	26028 -5.0	26463 7.4	26988 18.2	27542 26.5	28113 31.8	28699 33.7	29318 32.4	29980 28.5	30674 22.8	31363 16.3	31997 9.9	32543 4.2	30
25	19789 -16.2	20174 -2.2	20668 9.9	21205 19.3	21755 25.4	22327 28.0	22955 27.4	23654 24.5	24404 20.1	25145 15.1	25801 10.5	26317 6.8	25
20	12813 -28.1	13138 -13.0	13576 -.1	14055 9.9	14553 16.6	15094 20.0	15720 20.6	16455 19.3	17265 17.0	18067 14.6	18757 12.6	19259 11.6	20
15	5453 -39.3	5661 -23.6	5990 -10.2	6373 .2	6793 7.6	7288 12.1	7907 14.5	8672 15.4	9535 15.8	10389 16.2	11106 17.1	11592 18.7	15
10	-1853 -48.6	-1825 -32.5	-1664 -18.7	-1419 -7.5	-1101 1.1	-663 7.3	-56 11.9	728 15.3	1624 18.3	2502 21.2	3215 24.2	3660 27.3	10
5	-8608 -54.9	-8816 -38.4	-8870 -23.8	-8807 -11.5	-8613 -.9	-8243 7.7	-7659 14.8	-6873 20.6	-5977 25.5	-5121 29.7	-4464 33.1	-4112 35.8	5
0	-14361 -37.5	-14836 -29.2	-15140 -24.6	-15277 -10.1	-15220 2.7	-14926 13.8	-14377 23.4	-13618 30.9	-12769 36.5	-11899 40.2	-11468 41.9	-11278 42.5	0
LAT													LAT
E. LONG	0	5	10	15	20	25	30	35	40	45	50	55	E. LONG

nT
(units: nT)

VERTICAL COMPONENT (Z) WMM-90

E. LONG / LAT	60	65	70	75	80	85	90	95	100	105	110	115	E. LONG / LAT
90	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	90
85	56302 -17.6	56425 -18.4	56543 -19.1	56658 -19.9	56769 -20.7	56872 -21.4	56967 -22.2	57052 -22.9	57127 -23.6	57191 -24.2	57243 -24.8	57285 -25.3	85
80	56320 -11.1	56620 -12.6	56914 -14.2	57196 -15.8	57459 -17.4	57699 -18.9	57910 -20.5	58089 -22.0	58232 -23.3	58339 -24.6	58407 -25.8	58437 -26.7	80
75	56255 -3.2	56763 -5.0	57262 -7.0	57741 -9.1	58186 -11.2	58586 -13.3	58930 -15.4	59209 -17.5	59415 -19.5	59544 -21.3	59593 -23.0	59564 -24.4	75
70	55913 4.6	56622 2.8	57325 1.0	58003 -1.0	58635 -3.1	59201 -5.3	59682 -7.6	60059 -9.9	60319 -12.2	60452 -14.4	60455 -16.3	60325 -17.9	70
65	55150 10.4	56019 9.1	56890 7.8	57739 6.4	58534 4.8	59247 3.1	59847 1.2	60308 -.9	60607 -2.9	60728 -5.0	60661 -6.9	60407 -8.6	65
60	53879 13.1	54845 12.4	55825 11.7	56786 11.1	57694 10.4	58510 9.6	59194 8.6	59711 7.4	60028 6.1	60121 4.7	59975 3.2	59588 1.9	60
55	52063 12.6	53052 12.0	54065 11.8	55066 11.9	56017 12.2	56874 12.6	57592 12.9	58127 13.0	58437 12.9	58490 12.7	58264 12.2	57753 11.7	55
50	49672 9.5	50614 8.5	51582 8.3	52545 8.8	53464 10.0	54295 11.6	54990 13.4	55501 15.2	55779 16.8	55786 18.1	55490 19.0	54880 19.6	50
45	46657 5.2	47493 3.3	48349 2.8	49202 3.5	50020 5.3	50763 8.1	51383 11.4	51832 14.9	52060 18.3	52020 21.3	51676 23.6	51006 25.2	45
40	42934 1.3	43625 -1.4	44320 -2.3	45010 -1.8	45673 .9	46276 4.7	46780 9.4	47140 14.4	47307 19.4	47233 23.7	46870 27.1	46188 29.2	40
35	38405 -.7	38932 -3.6	39441 -4.6	39936 -3.5	40410 -.4	40842 4.3	41204 10.1	41460 16.3	41568 22.2	41477 27.2	41134 30.7	40495 32.4	35
30	32991 .2	33359 -2.1	33678 -2.3	33971 -.4	34244 3.4	34493 8.9	34704 15.3	34855 22.0	34916 28.1	34835 32.6	34553 35.2	34010 35.4	30
25	26677 4.5	26907 3.8	27052 4.9	27153 7.8	27235 12.5	27307 18.4	27375 25.0	27436 31.5	27469 36.7	27429 39.8	27247 40.3	26849 38.0	25
20	19551 11.7	19666 13.1	19661 15.7	19593 19.7	19504 24.9	19422 30.8	19370 37.0	19364 42.4	19398 46.0	19430 47.0	19380 44.7	19163 39.3	20
15	11822 21.0	11833 23.9	11695 27.6	11480 32.1	11244 37.1	11033 42.5	10889 47.5	10847 51.4	10911 53.0	11040 51.5	11146 46.5	11129 38.2	15
10	3809 30.5	3708 33.8	3437 37.3	3082 41.1	2712 45.1	2390 49.2	2176 52.7	2120 54.7	2234 54.5	2472 51.0	2739 44.0	2924 33.7	10
5	-4086 38.0	-4332 39.9	-4759 41.7	-5271 43.6	-5784 45.7	-6219 47.9	-6502 49.7	-6571 50.2	-6411 48.6	-6073 44.1	-5661 36.5	-5295 26.0	5
0	-11438 41.3	-11883 39.9	-12512 38.6	-13220 37.7	-13911 37.5	-14491 37.7	-14871 38.0	-14984 37.6	-14812 35.7	-14412 31.5	-13897 24.9	-13352 15.9	0
LAT / E. LONG	60	65	70	75	80	85	90	95	100	105	110	115	LAT / E. LONG

VERTICAL COMPONENT (Z) WMM-90

E. LONG / LAT	120	125	130	135	140	145	150	155	160	165	170	175	E. LONG / LAT
90	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	90
85	57315 -25.7	57334 -26.1	57343 -26.4	57344 -26.6	57336 -26.8	57321 -26.9	57301 -26.9	57277 -26.9	57249 -26.8	57219 -26.7	57188 -26.5	57157 -26.3	85
80	58432 -27.5	58395 -28.1	58328 -28.5	58238 -28.8	58129 -28.8	58007 -28.6	57879 -28.3	57751 -27.8	57627 -27.2	57513 -26.6	57412 -25.9	57328 -25.2	80
75	59462 -25.4	59293 -26.2	59067 -26.6	58798 -26.6	58498 -26.2	58183 -25.6	57866 -24.6	57563 -23.5	57285 -22.1	57045 -20.7	56849 -19.2	56706 -17.9	75
70	60076 -19.2	59716 -20.0	59263 -20.3	58745 -20.1	58185 -19.4	57609 -18.3	57045 -16.7	56518 -14.8	56051 -12.7	55661 -10.5	55363 -8.3	55162 -6.3	70
65	59977 -9.9	59391 -10.7	58677 -10.9	57872 -10.6	57014 -9.7	56147 -8.3	55310 -6.4	54543 -4.1	53875 -1.6	53335 1.0	52941 3.5	52704 5.8	65
60	58972 .9	58155 .2	57174 .0	56080 .3	54929 1.0	53778 2.2	52682 3.8	51691 5.7	50846 7.8	50176 10.0	49702 12.2	49441 14.3	60
55	56968 11.2	55943 10.8	54725 10.6	53378 10.6	51973 10.7	50584 11.1	49278 11.6	48112 12.5	47134 13.1	46376 14.1	45859 15.1	45593 16.3	55
50	53965 19.8	52779 19.7	51380 19.4	49864 18.9	48256 18.1	46703 17.2	45261 16.1	43996 14.9	42954 13.6	42167 12.5	41652 11.8	41414 11.5	50
45	50013 26.0	48733 26.1	47229 25.5	45587 24.3	43904 22.6	42278 20.3	40793 17.4	39514 14.1	38490 10.7	37747 7.2	37295 4.3	37131 2.2	45
40	45183 30.1	43884 29.9	42361 28.7	40706 26.7	39028 24.0	37429 20.7	35998 16.7	34800 12.0	33880 6.9	33258 1.6	32938 -3.2	32905 -7.1	40
35	39544 32.6	38307 31.3	36853 29.0	35283 26.7	33710 22.9	32241 19.3	30962 15.2	29937 10.6	29203 5.3	28778 -.6	28656 -6.4	28811 -11.7	35
30	33179 33.7	32078 30.5	30778 26.7	29384 22.8	28013 19.5	26769 16.6	25733 14.0	24962 11.2	24687 7.6	24322 3.0	24453 -2.6	24843 -8.5	30
25	26193 33.5	25293 27.7	24418 21.8	23077 17.0	21988 14.0	21048 12.9	20326 13.1	19874 11.7	19713 13.8	19850 12.2	20266 8.5	20907 2.9	25
20	18723 31.6	18069 22.9	17470 15.0	16436 9.2	15682 6.8	15096 7.9	14735 11.8	14633 17.1	14808 21.9	15262 24.6	15965 23.9	16852 19.5	20
15	10926 27.8	10539 16.4	10040 6.7	9537 .3	9136 -1.5	8916 1.7	8915 9.1	9161 18.8	9662 28.6	10413 35.9	11377 38.8	12481 36.2	15
10	2956 21.4	2836 8.8	2629 -1.9	2645 -8.6	2379 -9.8	2493 -5.2	2819 4.5	3370 17.4	4150 30.9	5150 42.0	6328 48.2	7604 47.8	10
5	-5052 13.7	-4936 1.2	-4876 -9.2	-4782 -15.7	-4565 -16.8	-4176 -11.9	-3592 -1.7	-2807 12.2	-1817 27.2	-634 40.3	697 48.7	2092 50.4	5
0	-12980 5.5	-12669 -5.0	-12400 -13.9	-12088 -19.6	-11659 -20.8	-11072 -16.8	-10311 -8.0	-9371 4.3	-8246 18.1	-6950 30.9	-5524 40.0	-4052 43.3	0
LAT / E. LONG	120	125	130	135	140	145	150	155	160	165	170	175	LAT / E. LONG

VERTICAL COMPONENT (Z) WMM-90

E. LONG / LAT	180	185	190	195	200	205	210	215	220	225	230	235	E. LONG / LAT
90	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	90
85	57127 -26.0	57097 -25.8	57068 -25.5	57040 -25.2	57013 -24.9	56986 -24.6	56959 -24.3	56932 -24.0	56903 -23.7	56872 -23.4	56838 -23.0	56801 -22.7	85
80	57262 -24.5	57216 -23.8	57190 -23.3	57181 -22.8	57189 -22.4	57211 -22.0	57242 -21.8	57280 -21.7	57319 -21.6	57355 -21.5	57386 -21.5	57402 -21.5	80
75	56618 -16.6	56586 -15.6	56609 -14.9	56682 -14.4	56799 -14.3	56953 -14.4	57135 -14.9	57333 -15.5	57538 -16.4	57739 -17.4	57925 -18.4	58087 -19.4	75
70	55077 -4.7	55092 -3.4	55210 -2.7	55421 -2.6	55712 -3.1	56070 -4.2	56477 -5.8	56915 -7.9	57365 -10.4	57808 -13.0	58227 -15.7	58604 -18.2	70
65	52630 7.6	52717 8.9	52957 9.4	53336 9.1	53836 7.8	54436 5.6	55108 2.5	55827 -1.3	56564 -5.7	57293 -10.4	57988 -15.0	58625 -19.5	65
60	49393 16.0	49556 17.1	49919 17.5	50464 16.9	51168 15.1	52002 12.0	52933 7.7	53926 2.3	54947 -3.9	55960 -10.5	56935 -17.1	57841 -23.3	60
55	45579 17.5	45812 18.4	46278 18.8	46957 18.4	47823 16.7	48844 13.6	49982 8.8	51199 2.6	52453 -4.9	53706 -13.1	54923 -21.4	56071 -29.1	55
50	41448 11.8	41746 12.4	42289 13.1	43057 13.4	44025 12.7	45159 10.4	46423 6.2	47778 .0	49182 -7.9	50596 -17.0	51984 -26.3	53314 -35.1	50
45	37242 1.3	37610 1.5	38213 2.5	39030 3.8	40035 4.4	41203 3.7	42502 .9	43898 -4.3	45354 -11.7	46833 -20.8	48306 -30.5	49738 -39.8	45
40	33134 -9.5	33593 -10.1	34253 -9.2	35087 -7.4	36078 -5.4	37208 -4.5	38458 -5.7	39805 -9.4	41220 -15.7	42675 -24.0	44142 -33.3	45596 -42.3	40
35	29202 -15.7	29778 -17.8	30497 -18.0	31331 -16.6	32267 -14.6	33304 -13.0	34440 -12.9	35669 -15.1	36974 -19.9	38332 -26.7	39720 -34.6	41119 -42.3	35
30	25425 -14.0	26136 -18.3	26916 -20.9	27734 -21.9	28588 -21.5	29496 -20.8	30478 -20.7	31546 -22.1	32695 -25.3	33907 -29.9	35162 -35.3	36444 -40.3	30
25	21694 -4.0	22539 -11.1	23372 -17.5	24162 -22.5	24919 -25.9	25682 -28.1	26494 -29.6	27384 -30.9	28354 -32.6	29391 -34.4	30476 -36.1	31597 -37.0	25
20	17829 11.7	18791 1.7	19664 -9.2	20417 -19.6	21077 -28.3	21700 -34.9	22350 -39.2	23066 -41.4	23857 -41.6	24711 -40.1	25608 -37.0	26542 -32.5	20
15	13616 28.2	14672 15.8	15570 .7	16291 -15.1	16871 -29.6	17384 -41.1	17902 -48.7	18473 -51.9	19106 -50.7	19788 -45.6	20504 -37.1	21252 -26.3	15
10	8858 40.4	9985 26.8	10908 8.8	11615 -11.1	12154 -30.0	12606 -45.7	13047 -56.0	13523 -59.9	14043 -57.1	14593 -48.2	15161 -34.4	15755 -17.4	10
5	3436 44.5	4622 31.5	5582 13.0	6311 -8.3	6863 -29.3	7318 -46.9	7750 -58.4	8201 -62.1	8675 -57.6	9159 -45.3	9644 -27.0	10144 -5.1	5
0	-2644 39.7	-1600 29.1	-380 12.9	416 -6.7	1040 -26.4	1567 -43.1	2063 -53.7	2564 -56.3	3073 -49.9	3575 -35.2	4060 -14.1	4545 10.7	0
LAT / E. LONG	180	185	190	195	200	205	210	215	220	225	230	235	LAT / E. LONG

VERTICAL COMPONENT (Z) WMM-90

E. LONG LAT	240	245	250	255	260	265	270	275	280	285	290	295	E. LONG LAT
90	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	90
85	56759 -22.4	56712 -22.0	56660 -21.6	56602 -21.2	56538 -20.8	56469 -20.3	56395 -19.9	56315 -19.4	56232 -18.9	56145 -18.3	56056 -17.8	55966 -17.2	85
80	57405 -21.4	57389 -21.3	57353 -21.2	57294 -20.9	57210 -20.5	57101 -20.1	56969 -19.5	56813 -18.8	56636 -18.0	56440 -17.1	56229 -16.1	56006 -15.0	80
75	58216 -20.3	58304 -21.0	58346 -21.6	58335 -22.0	58270 -22.1	58149 -22.0	57971 -21.6	57741 -21.0	57461 -20.2	57137 -19.1	56776 -17.8	56387 -16.2	75
70	58926 -20.6	59178 -22.6	59350 -24.2	59434 -25.4	59424 -26.2	59316 -26.8	59111 -26.6	58812 -26.2	58427 -25.5	57963 -24.5	57435 -23.1	56856 -21.3	70
65	59183 -23.4	59644 -26.7	59990 -29.3	60209 -31.3	60291 -32.6	60229 -33.4	60021 -33.8	59671 -33.8	59188 -33.4	58586 -32.7	57884 -31.5	57106 -29.8	65
60	58653 -28.8	59345 -33.2	59896 -36.6	60286 -39.0	60497 -40.5	60518 -41.5	60342 -42.2	59970 -42.5	59412 -42.7	58688 -42.6	57823 -42.1	56852 -40.9	60
55	57121 -35.7	58043 -40.9	58811 -44.7	59394 -47.2	59769 -48.7	59911 -49.7	59806 -50.5	59451 -51.4	58854 -52.4	58036 -53.4	57034 -53.9	55891 -53.5	55
50	54557 -42.6	55681 -48.3	56653 -52.2	57434 -54.5	57989 -55.8	58280 -56.7	58283 -57.8	57985 -59.5	57389 -61.7	56518 -64.1	55413 -66.2	54128 -67.2	50
45	51107 -47.7	52389 -53.5	53516 -57.3	54475 -59.3	55203 -60.4	55653 -61.5	55785 -63.2	55575 -66.2	55019 -70.1	54136 -74.6	52968 -78.7	51580 -81.4	45
40	47013 -49.9	48364 -55.4	49609 -58.7	50697 -60.4	51567 -61.5	52160 -63.0	52422 -65.9	52318 -70.7	51831 -77.1	50975 -84.2	49788 -90.9	48336 -95.8	40
35	42508 -48.7	43863 -53.1	45145 -55.6	46301 -56.9	47266 -57.9	47971 -60.3	48351 -65.0	48357 -72.3	47961 -81.8	47164 -92.3	45997 -102.2	44523 -109.8	35
30	37738 -44.2	39027 -46.4	40279 -47.3	41445 -47.7	42458 -49.0	43242 -52.6	43723 -59.5	43839 -68.9	43549 -83.0	42841 -97.5	41732 -111.1	40276 -122.0	30
25	32746 -36.8	33917 -35.6	35091 -33.9	36226 -32.9	37252 -34.2	38095 -39.2	38669 -48.7	38900 -62.9	38731 -79.7	38136 -98.4	37119 -116.3	35719 -131.0	25
20	27518 -26.9	28543 -20.9	29613 -15.8	30695 -13.0	31729 -14.2	32629 -20.5	33303 -32.6	33600 -49.8	33629 -71.2	33169 -94.2	32269 -116.3	30956 -135.1	20
15	22053 -14.5	22930 -3.2	23895 5.8	24930 10.6	25976 9.8	26946 2.2	27732 -12.5	28229 -32.9	28352 -57.9	28042 -84.7	27277 -110.4	26068 -135.5	15
10	16407 .4	17159 16.8	18038 29.3	19038 36.0	20107 35.2	21153 26.4	22060 9.8	22708 -13.5	22991 -41.3	22840 -71.2	22217 -100.3	21120 -126.3	10
5	10701 17.5	11368 37.6	12196 52.6	13161 60.2	14252 59.1	15369 49.1	16390 30.6	17182 .7	17625 -24.0	17632 -55.6	17152 -86.6	16169 -114.8	5
0	5073 35.6	5702 57.4	6485 73.0	7440 80.3	8539 78.3	9703 67.1	10813 47.5	11730 21.6	12323 -8.6	12484 -40.5	12147 -71.9	11285 -100.9	0
LAT E. LONG	240	245	250	255	260	265	270	275	280	285	290	295	LAT E. LONG

VERTICAL COMPONENT (Z) WMM-90

E. LONG LAT	300	305	310	315	320	325	330	335	340	345	350	355	E. LONG LAT
90	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	56401 -21.4	90
85	55876 -16.7	55788 -16.2	55702 -15.6	55621 -15.1	55546 -14.8	55477 -14.2	55418 -13.8	55367 -13.4	55326 -13.1	55300 -12.8	55295 -12.7	55283 -12.5	85
80	55775 -13.9	55542 -12.7	55310 -11.4	55085 -10.2	54670 -8.9	54671 -7.7	54491 -6.5	54334 -5.5	54203 -4.5	54101 -3.7	54030 -3.0	53993 -2.5	80
75	55977 -14.5	55558 -12.6	55137 -10.5	54726 -8.4	54331 -6.2	53963 -4.0	53628 -1.8	53333 .2	53081 2.1	52882 3.8	52735 5.2	52642 6.3	75
70	56242 -19.2	55610 -16.7	54977 -13.8	54358 -10.7	53768 -7.4	53219 -4.0	52722 -.7	52285 2.6	51916 5.6	51618 8.3	51395 10.6	51250 12.4	70
65	56277 -27.6	55424 -24.7	54572 -21.2	53744 -17.1	52962 -12.6	52243 -7.9	51599 -3.1	51040 1.6	50573 5.9	50201 9.8	49925 13.1	49746 15.8	65
60	55813 -38.8	54744 -35.8	53683 -31.7	52661 -26.7	51708 -21.0	50843 -14.8	50082 -8.4	49432 -2.2	48899 3.6	48485 8.8	48188 13.2	48005 16.8	60
55	54659 -52.0	53393 -49.0	52142 -44.5	50952 -38.6	49856 -31.5	48877 -23.8	48031 -15.8	47323 -8.0	46756 -.7	46330 5.8	46041 11.4	45882 16.1	55
50	52732 -66.5	51293 -63.7	49879 -58.8	48545 -51.9	47332 -43.5	46268 -34.3	45363 -24.8	44623 -15.5	44044 -6.9	43626 .9	43363 7.8	43249 13.7	50
45	50051 -81.8	48466 -79.4	46909 -74.2	45450 -66.5	44138 -56.9	43002 -46.3	42052 -35.5	41287 -25.0	40703 -15.2	40297 -6.1	40065 2.1	40003 9.5	45
40	46708 -97.7	45002 -96.1	43316 -90.8	41739 -82.5	40327 -72.0	39112 -60.4	38106 -48.5	37304 -37.0	36701 -26.1	36294 -15.9	36083 -6.3	36064 2.9	40
35	42831 -113.7	41029 -113.2	39227 -108.4	37523 -100.0	35988 -89.0	34663 -76.7	33561 -64.1	32682 -51.8	32021 -40.1	31581 -28.7	31363 -17.5	31366 -6.3	35
30	38557 -128.6	36684 -130.0	34770 -126.3	32923 -119.5	31226 -107.7	29734 -95.3	28471 -82.3	27448 -69.4	26669 -56.7	26143 -44.0	25878 -31.1	25868 -18.0	30
25	34010 -140.8	32089 -144.9	30068 -145.3	28057 -138.9	26151 -127.0	24421 -115.0	22917 -102.0	21669 -88.5	20699 -74.8	20027 -60.7	19662 -46.1	19596 -31.1	25
20	29285 -148.7	27339 -156.1	25216 -157.4	23024 -153.4	20869 -145.2	18843 -134.2	17028 -121.4	15485 -107.5	14259 -92.7	13383 -77.2	12867 -61.0	12695 -44.4	20
15	24455 -151.0	22500 -162.2	20296 -167.0	17914 -165.9	15497 -160.0	13155 -150.5	11001 -138.3	9131 -124.2	7616 -108.6	6500 -91.8	5793 -74.3	5466 -56.5	15
10	19574 -147.3	17624 -162.2	15341 -170.5	12817 -172.8	10175 -169.6	7554 -162.0	5097 -150.8	2929 -136.8	1143 -120.7	-212 -103.1	-1132 -84.7	-1654 -66.2	10
5	14698 -138.4	12775 -156.2	10461 -167.8	7850 -173.1	5068 -172.7	2268 -167.1	-389 -157.2	-2762 -143.9	-4750 -127.9	-6306 -110.1	-7432 -91.3	-8175 -72.8	5
0	9904 -125.7	8041 -145.4	5759 -159.3	3151 -167.1	353 -169.0	-2682 -165.4	-5191 -157.1	-7636 -144.8	-9721 -129.5	-11409 -112.3	-12710 -94.0	-13673 -75.5	0
LAT E. LONG	300	305	310	315	320	325	330	335	340	345	350	355	LAT E. LONG

VERTICAL COMPONENT (Z) WMM-90

E. LONG / LAT	0	5	10	15	20	25	30	35	40	45	50	55	E. LONG / LAT
0	-14363 -37.5	-14836 -40.2	-15240 -24.8	-15277 -10.1	-15229 2.7	-14926 13.8	-14377 23.4	-13818 38.6	-12769 36.5	-11899 40.2	-11468 41.9	-11378 45.2	0
-5	-19823 -55.5	-19551 -37.7	-20090 -20.3	-20415 -3.8	-20494 11.5	-20265 24.9	-19769 35.9	-19075 44.0	-18332 48.5	-17722 49.7	-17402 47.9	-17455 43.8	-5
-10	-21915 -43.1	-22827 -29.6	-23534 -11.0	-23989 7.1	-24146 23.9	-23989 38.5	-23541 49.3	-22977 56.0	-22410 57.8	-22043 55.0	-22019 48.2	-22398 38.9	-10
-15	-23760 -34.8	-24739 -15.9	-25505 2.9	-26001 21.3	-26186 37.9	-26069 51.4	-25727 60.3	-25302 63.7	-24979 61.2	-24933 53.2	-25282 41.1	-26057 26.7	-15
-20	-24607 -14.7	-25525 5.2	-26230 21.0	-26672 37.6	-26828 51.8	-26738 61.8	-26501 66.5	-26281 64.9	-26261 57.0	-26593 43.8	-27365 27.0	-28574 8.9	-20
-25	-24752 10.6	-25506 26.7	-26063 41.8	-26390 54.7	-26492 64.2	-26430 68.8	-26330 67.5	-26354 59.9	-26670 46.4	-27406 28.5	-28605 8.5	-30241 -11.1	-25
-30	-24675 39.2	-25022 52.6	-25403 63.7	-25611 71.4	-25676 74.7	-25679 72.7	-25751 64.7	-26046 51.0	-26701 32.7	-27815 11.6	-29603 -9.9	-31612 -29.5	-30
-35	-24032 67.7	-24392 77.6	-24636 84.5	-24774 86.5	-24660 83.4	-24982 74.8	-25261 60.8	-25830 47.2	-26801 20.6	-28236 -2.0	-30125 -23.0	-32610 -40.4	-35
-40	-23669 92.4	-23909 99.4	-24089 101.7	-24240 99.8	-24618 90.4	-24710 76.9	-25217 58.5	-26045 37.1	-27273 14.2	-28939 -7.9	-31026 -27.0	-33470 -41.3	-40
-45	-23646 109.9	-23842 114.3	-24038 113.4	-24270 107.1	-24593 95.5	-25078 79.4	-25806 59.6	-26847 37.9	-28260 16.1	-30063 -3.9	-32235 -20.2	-34722 -31.3	-45
-50	-24216 118.5	-24429 121.0	-24690 118.4	-25036 110.9	-25513 98.8	-26174 82.8	-27076 64.3	-28268 44.7	-29782 25.7	-31627 9.1	-33784 -3.9	-36212 -12.3	-50
-55	-25599 118.5	-25848 119.9	-26181 117.1	-26629 110.7	-27227 99.7	-28011 86.3	-29017 71.1	-30275 55.4	-31803 40.6	-33603 27.7	-35661 17.9	-37946 11.7	-55
-60	-27906 112.5	-28182 111.4	-28562 111.3	-29069 108.3	-29727 98.6	-30558 89.0	-31586 78.1	-32826 67.0	-34283 56.6	-35961 47.5	-37847 40.5	-39918 35.9	-60
-65	-31115 103.9	-31397 104.7	-31787 103.5	-32301 100.4	-32953 96.0	-33758 90.1	-34728 85.6	-35869 78.7	-37185 70.2	-38674 64.4	-40326 59.7	-42125 56.2	-65
-70	-35098 98.5	-35359 96.9	-35722 96.5	-36196 95.1	-36788 92.9	-37506 90.0	-38355 86.7	-39339 84.1	-40456 79.6	-41699 76.2	-43065 75.3	-44541 70.7	-70
-75	-39642 91.8	-39864 92.1	-40172 92.0	-40570 91.5	-41061 90.6	-41647 89.4	-42330 88.0	-43109 86.4	-43981 84.7	-44942 82.9	-45987 81.2	-47106 79.5	-75
-80	-44505 90.4	-44672 90.4	-44901 90.2	-45196 90.0	-45551 89.6	-45971 89.1	-46452 88.5	-46994 87.8	-47592 87.0	-48245 86.2	-48946 85.3	-49691 84.4	-80
-85	-49421 90.3	-49516 90.1	-49643 89.9	-49803 89.7	-49995 89.5	-50217 89.2	-50469 88.9	-50748 88.6	-51054 88.3	-51383 87.9	-51732 87.5	-52101 87.1	-85
-90	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-90
LAT / E. LONG	0	5	10	15	20	25	30	35	40	45	50	55	LAT / E. LONG

VERTICAL COMPONENT (Z) WMM-90

E. LONG / LAT	60	65	70	75	80	85	90	95	100	105	110	115	LAT
0	-11438 41.3	-11883 39.9	-12512 38.6	-13220 37.7	-13911 37.5	-14491 37.7	-14871 38.0	-14984 37.6	-14812 35.7	-14412 31.5	-13807 24.9	-13392 15.9	0
-5	-17875 36.4	-18585 32.7	-19476 27.6	-20436 23.7	-21357 21.5	-22136 20.2	-22672 19.7	-22890 19.4	-22772 18.1	-22378 15.5	-21824 11.3	-21242 5.5	-5
-10	-23153 28.4	-24195 18.4	-25607 10.0	-26674 4.0	-27884 .4	-28925 -1.2	-29688 -1.3	-30091 -.8	-30114 -.3	-29611 -.5	-29301 -1.5	-28716 -3.3	-10
-15	-27206 12.1	-28629 -.9	-30205 -11.1	-31821 -17.4	-33364 -21.0	-34719 -21.6	-35774 -20.1	-36440 -17.0	-36689 -15.5	-36569 -13.0	-36189 -10.8	-35678 -8.9	-15
-20	-30147 -8.1	-31970 -22.1	-33926 -31.9	-35903 -37.2	-37796 -38.5	-39488 -36.8	-40872 -33.2	-41855 -28.9	-42400 -24.3	-42538 -19.8	-42365 -15.3	-42001 -10.8	-20
-25	-32222 -28.4	-34427 -41.1	-36740 -46.4	-38056 -50.8	-41277 -48.6	-43298 -45.9	-45016 -37.9	-46335 -31.6	-47219 -25.7	-47656 -20.3	-47748 -15.0	-47591 -9.6	-25
-30	-33739 -44.4	-36265 -53.9	-38878 -57.4	-41480 -55.8	-43981 -50.0	-46290 -42.9	-48307 -34.2	-49944 -26.8	-51159 -20.7	-51921 -15.7	-52319 -11.2	-52399 -6.8	-30
-35	-34986 -52.2	-37739 -57.8	-40566 -57.2	-43376 -51.7	-46089 -43.1	-48620 -33.3	-50882 -24.2	-52794 -16.8	-54300 -11.6	-55384 -8.3	-56073 -6.0	-56426 -3.8	-35
-40	-36178 -49.8	-39049 -51.5	-41990 -47.8	-44919 -39.9	-47760 -29.8	-50438 -19.4	-52877 -10.7	-55001 -4.5	-56756 -1.2	-58114 -.3	-59082 -.8	-59694 -1.6	-40
-45	-37447 -36.6	-40325 -36.2	-43278 -31.0	-46230 -22.5	-49113 -12.8	-51857 -3.6	-54396 3.5	-56658 7.8	-58593 8.5	-60167 6.8	-61369 3.6	-62215 .1	-45
-50	-38852 -15.7	-41639 -14.4	-44505 -9.5	-47387 -2.4	-50270 5.3	-52943 12.0	-55696 16.5	-57812 18.1	-59847 16.7	-61561 13.0	-62936 7.8	-63969 2.5	-50
-55	-40617 9.2	-43026 10.0	-45713 13.3	-48631 17.4	-51121 22.5	-53729 26.1	-56199 27.8	-58478 27.1	-60521 24.0	-62289 19.1	-63759 13.2	-64919 7.1	-55
-60	-42149 35.6	-44493 33.3	-46927 34.4	-49391 36.2	-51844 37.8	-54239 38.6	-56530 37.9	-58670 35.6	-60621 31.8	-62349 26.7	-63827 20.9	-65041 15.3	-60
-65	-44050 54.0	-46075 52.7	-48169 52.0	-50298 51.6	-52427 51.0	-54517 49.8	-56533 47.7	-58438 44.8	-60201 40.9	-61792 36.5	-63189 31.8	-64378 27.4	-65
-70	-46112 68.7	-47758 66.8	-49659 65.3	-51189 63.8	-52923 62.1	-54635 60.1	-56297 57.7	-57884 54.9	-59372 51.8	-60741 48.5	-61971 45.2	-63051 42.2	-70
-75	-48288 77.9	-49522 76.5	-50793 74.7	-52086 73.1	-53383 71.4	-54669 69.6	-55925 67.6	-57136 65.6	-58286 63.5	-59360 61.5	-60347 59.5	-61237 57.8	-75
-80	-50472 83.3	-51283 82.1	-52115 81.2	-52959 80.1	-53808 79.0	-54651 77.9	-55479 76.8	-56284 75.6	-57056 74.6	-57788 73.5	-58473 72.6	-59104 71.8	-80
-85	-52485 86.7	-52880 86.2	-53285 85.8	-53695 85.3	-54107 84.9	-54516 84.5	-54920 84.1	-55315 83.7	-55697 83.3	-56063 83.0	-56410 82.7	-56735 82.5	-85
-90	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-90
LAT / E. LONG	60	65	70	75	80	85	90	95	100	105	110	115	LAT / E. LONG

VERTICAL COMPONENT (Z) WMM-90

E. LONG / LAT	120	125	130	135	140	145	150	155	160	165	170	175	LAT
0	-12980 5.5	-12669 -5.0	-12400 -13.9	-12088 -19.6	-11659 -20.8	-11072 -16.8	-10311 -8.0	-9371 4.3	-8246 18.1	6950 30.9	-5524 40.0	-4052 41.5	0
-5	-20719 -1.4	-20272 -8.6	-19855 -14.9	-19397 -19.2	-18826 -20.6	-18118 -18.5	-17255 -12.8	-16229 -4.1	-15035 6.3	-13681 16.6	-12207 24.9	-10692 29.2	-5
-10	-29149 -5.9	-27630 -9.0	-27127 -12.0	-26581 -14.6	-25940 -16.2	-25173 -16.2	-24262 -14.3	-23200 -10.3	-21978 -4.7	-20605 1.9	-19115 8.2	-17576 12.9	-10
-15	-35136 -7.5	-34606 -8.0	-34074 -8.4	-33496 -7.0	-32829 -8.4	-32041 -10.1	-31117 -11.6	-30044 -12.1	-28819 -11.2	-27446 -8.6	-25957 -4.7	-24409 -.4	-15
-20	-41549 -6.5	-41062 -2.6	-40546 .2	-39973 1.3	-39308 .6	-38521 -1.8	-37597 -5.4	-36526 -8.9	-35305 -11.5	-33941 -12.0	-32463 -10.2	-30918 -6.3	-20
-25	-47281 -4.1	-46884 1.1	-46419 5.4	-45876 8.0	-45224 8.4	-44446 6.4	-43527 2.7	-42459 -1.8	-41246 -5.7	-39898 -7.8	-38439 -7.2	-36907 -3.8	-25
-30	-52275 -2.0	-52003 3.0	-51616 7.6	-51112 11.1	-50485 12.8	-49718 12.4	-48804 10.1	-47742 6.6	-46540 3.8	-45212 2.1	-43781 2.5	-42278 5.5	-30
-35	-56513 -1.1	-56392 2.2	-56101 6.1	-55657 9.8	-55060 12.8	-54308 14.5	-53403 15.0	-52352 14.5	-51168 13.9	-49870 13.9	-48474 15.1	-47022 17.8	-35
-40	-60009 -1.7	-60048 -.6	-59875 1.9	-59506 5.4	-58954 9.3	-58231 13.1	-57348 16.4	-56321 19.2	-55169 21.6	-53916 24.0	-52578 26.6	-51186 29.3	-40
-45	-62732 -2.6	-62955 -3.7	-62918 -2.8	-62648 .0	-62170 4.3	-61503 9.5	-60669 15.1	-59692 20.6	-58596 25.8	-57407 30.3	-56149 34.1	-54844 37.0	-45
-50	-64672 -2.0	-65068 -4.8	-65181 -5.2	-65040 -3.2	-64671 .8	-64102 6.5	-63361 13.2	-62476 20.2	-61476 26.9	-60388 32.8	-59238 37.4	-58047 40.4	-50
-55	-65769 1.9	-66320 -1.5	-66591 -2.8	-66604 -1.7	-66385 1.7	-65962 6.9	-65366 13.4	-64625 20.4	-63771 27.3	-62830 33.4	-61826 38.2	-60782 41.1	-55
-60	-65985 10.5	-66661 7.1	-67080 5.5	-67258 6.0	-67217 8.4	-66981 12.5	-66577 17.6	-66031 23.7	-65371 29.7	-64620 35.1	-63802 39.5	-62935 42.1	-60
-65	-65349 23.6	-66092 20.3	-66634 19.4	-66963 19.4	-67100 20.9	-67063 23.7	-66871 27.3	-66546 31.6	-66108 36.0	-65577 40.0	-64968 43.5	-64298 45.8	-65
-70	-63970 39.6	-64745 37.8	-65319 36.7	-65746 36.6	-66023 37.3	-66156 38.8	-66157 41.0	-66040 44.8	-65816 48.4	-65499 49.7	-65100 51.8	-64629 53.6	-70
-75	-62022 58.4	-62698 55.3	-63261 54.7	-63712 54.3	-64052 54.8	-64285 55.5	-64415 56.6	-64449 58.0	-64392 59.5	-64251 61.1	-64032 62.7	-63739 64.1	-75
-80	-59677 71.2	-60187 70.7	-60830 70.4	-61306 70.4	-61312 70.4	-61549 70.7	-61717 71.2	-61818 71.8	-61852 72.5	-61823 73.3	-61732 74.2	-61580 75.1	-80
-85	-57035 82.3	-57309 82.1	-57553 82.1	-57767 82.1	-57949 82.1	-58098 82.2	-58216 82.4	-58295 82.6	-58342 82.9	-58356 83.2	-58336 83.5	-58277 83.9	-85
-90	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-90
LAT / E. LONG	120	125	130	135	140	145	150	155	160	165	170	175	LAT / E. LONG

VERTICAL COMPONENT (Z) WMM-90

E. LONG / LAT	180	185	190	195	200	205	210	215	220	225	230	235	E. LONG / LAT
0	-2644 19.7	-1400 29.1	-380 12.9	616 -6.7	1040 -26.4	1567 -43.1	2063 -53.7	2564 -56.4	3073 -49.9	3575 -37.2	4060 -14.1	4545 10.7	0
-5	-9234 28.3	-7925 21.6	-6820 10.0	-5916 -4.9	-5168 -20.4	-4511 -33.6	-3887 -41.5	-3266 -42.0	-2648 -34.2	-2050 -18.5	-1482 3.3	-935 28.2	-5
-10	-16078 14.6	-14699 12.6	-13488 6.9	-12449 -1.5	-11543 -11.0	-10717 -19.0	-9925 -23.1	-9141 -21.5	-8365 -13.0	-7616 2.1	-6908 22.2	-6240 44.7	-10
-15	-22877 1.6	-21429 5.9	-20109 6.1	-18924 4.2	-17851 1.1	-16849 -1.7	-15879 -2.3	-14921 .9	-13975 8.9	-13058 21.8	-12188 38.3	-11369 56.4	-15
-20	-29363 -1.0	-27858 4.4	-26442 9.0	-25127 12.1	-23903 13.8	-22742 14.9	-21616 16.5	-20507 19.9	-19414 26.2	-18348 35.6	-17325 47.4	-16354 60.4	-20
-25	-35348 1.8	-33810 8.5	-32327 15.1	-30817 20.6	-29581 24.6	-28303 27.1	-27065 29.0	-25851 31.2	-24654 34.7	-23478 40.0	-22332 47.2	-21220 55.3	-25
-30	-40739 10.5	-39199 16.7	-37692 22.9	-36236 28.0	-34841 31.3	-33502 32.8	-32205 33.0	-30937 32.7	-29684 32.9	-28439 34.5	-27199 37.8	-25962 42.4	-30
-35	-45526 21.8	-44023 28.1	-42536 30.0	-41089 32.5	-39692 33.1	-38346 31.8	-37041 29.1	-35762 25.8	-34489 23.0	-33204 21.7	-31892 22.5	-30542 25.4	-35
-40	-49761 31.9	-48326 33.8	-46906 34.7	-45512 33.8	-44162 30.8	-42856 28.2	-41577 20.4	-40314 14.5	-39040 9.6	-37728 6.7	-36355 6.6	-34905 9.4	-40
-45	-53513 38.5	-52177 35.5	-50851 36.6	-49569 32.6	-48277 26.8	-47032 19.5	-45802 11.8	-44566 4.4	-43295 -1.2	-41960 -4.3	-40535 -4.2	-39001 -.5	-45
-50	-56836 41.3	-55620 40.1	-54411 36.7	-53216 31.1	-52035 24.0	-50863 15.9	-49683 7.7	-48472 .5	-47205 -4.6	-45852 -6.9	-44389 -5.7	-42801 -1.0	-50
-55	-59715 42.0	-58636 40.6	-57554 37.1	-56471 31.8	-55393 25.1	-54282 18.0	-53150 11.1	-51966 5.4	-50708 1.7	-49353 .8	-47882 3.0	-46284 8.4	-55
-60	-62032 43.2	-61105 42.4	-60157 40.0	-59188 36.2	-58194 31.5	-57164 26.6	-56085 22.0	-54941 18.6	-53714 16.9	-52389 17.3	-50955 20.2	-49406 25.4	-60
-65	-63577 47.3	-62811 47.4	-62006 46.5	-61159 44.8	-60267 42.5	-59324 40.2	-58320 38.2	-57245 37.0	-56089 36.9	-54845 38.3	-53508 41.2	-52079 45.7	-65
-70	-64093 55.1	-63497 56.0	-62845 58.3	-62137 56.5	-61371 56.1	-60545 55.8	-59656 55.7	-58699 56.1	-57671 57.1	-56570 58.8	-55398 61.3	-54158 64.5	-70
-75	-63378 65.4	-62953 66.6	-62465 67.6	-61917 68.5	-61310 69.3	-60645 70.1	-59921 71.0	-59140 72.0	-58302 73.3	-57411 74.8	-56468 76.6	-55480 78.6	-75
-80	-61372 76.0	-61108 77.0	-60791 77.9	-60423 78.8	-60005 79.7	-59541 80.6	-59032 81.5	-58481 82.5	-57890 83.5	-57263 84.5	-56604 85.5	-55916 86.5	-80
-85	-58189 84.3	-58069 84.7	-57918 85.2	-57738 85.7	-57529 86.1	-57294 86.6	-57034 87.1	-56750 87.6	-56445 88.0	-56122 88.5	-55782 88.9	-55427 89.3	-85
-90	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-90
LAT / E. LONG	180	185	190	195	200	205	210	215	220	225	230	235	LAT / E. LONG

VERTICAL COMPONENT (Z) WMM-90

E. LONG	240	245	250	255	260	265	270	275	280	285	290	295	E. LONG
LAT													LAT
0	5073 75.6	5702 57.4	6485 73.0	7640 60.3	8539 78.3	9703 67.1	10813 47.5	11730 21.6	12323 -8.6	12484 -40.5	12147 -71.9	11285 -100.9	0
-5	-370 52.9	271 73.8	1062 78.1	1978 93.9	3067 90.4	4249 78.0	5417 57.9	6434 33.1	7160 2.8	7472 -28.1	7286 -58.4	6561 -86.6	-5
-10	-5584 66.4	-4890 84.3	-4100 95.8	-3173 99.2	-2099 94.1	-916 81.0	288 61.3	1786 36.7	2233 9.3	2696 -18.3	2673 -47.3	2113 -74.5	-10
-15	-10587 73.6	-9800 87.3	-8956 95.3	-8005 96.3	-6923 90.1	-5729 77.2	-4488 58.8	-3315 36.5	-2350 11.9	-1733 -13.5	-1577 -38.5	-1945 -61.9	-15
-20	-15426 72.6	-14510 82.0	-13562 87.1	-12534 86.6	-11395 80.4	-10149 68.9	-8846 53.0	-7586 33.8	-6498 12.8	-5723 -9.1	-5378 -30.7	-5534 -51.1	-20
-25	-20136 81.3	-19060 69.7	-17956 73.2	-16787 72.8	-15524 68.1	-14169 59.4	-12764 47.0	-11397 31.7	-10175 14.5	-9241 -3.7	-8707 -22.1	-8647 -39.8	-25
-30	-24720 47.9	-23459 53.0	-22157 56.8	-20791 58.2	-19346 56.6	-17830 51.7	-16283 43.6	-14779 37.6	-13626 19.3	-12340 4.4	-11628 -11.1	-11362 -26.5	-30
-35	-29145 40.1	-27692 35.9	-26173 41.5	-24584 46.0	-22927 48.4	-21222 48.0	-19513 44.4	-17870 37.6	-16385 28.0	-15161 16.1	-14291 2.9	-13840 -10.5	-35
-40	-33365 14.9	-31734 22.4	-30014 30.7	-28215 38.6	-26357 45.0	-24474 48.9	-22615 49.4	-20847 46.4	-19251 40.0	-17913 30.7	-16910 19.3	-16297 7.6	-40
-45	-37348 6.4	-35579 15.7	-33705 26.5	-31749 37.2	-29744 46.7	-27732 53.7	-25768 57.4	-23915 57.3	-22243 53.5	-20823 46.4	-19715 37.0	-18961 28.6	-45
-50	-41081 7.0	-39235 17.5	-37282 29.4	-35252 41.5	-33183 52.5	-31122 61.1	-29123 66.5	-27245 68.2	-25546 66.2	-24086 61.0	-22903 53.4	-22032 44.6	-50
-55	-44557 16.6	-42713 26.9	-40772 38.5	-38765 50.1	-36730 60.6	-34713 69.1	-32764 74.8	-30932 77.2	-29265 76.4	-27806 72.7	-26589 66.9	-25631 59.9	-55
-60	-47747 32.7	-45989 41.6	-44152 51.2	-42266 60.8	-40363 69.5	-38483 76.5	-36666 81.3	-34951 83.6	-33377 83.4	-31973 80.9	-30763 76.7	-29759 71.6	-60
-65	-50563 51.3	-48973 57.8	-47326 64.8	-45645 71.5	-43958 77.6	-42292 82.5	-40679 85.9	-39147 87.5	-37723 87.5	-36427 85.6	-35276 83.2	-34278 79.9	-65
-70	-52857 68.3	-51505 72.4	-50117 76.6	-48708 80.6	-47298 84.1	-45906 86.9	-44552 88.8	-43256 89.8	-42033 89.8	-40899 88.9	-39864 87.3	-38935 85.4	-70
-75	-54452 80.7	-53393 82.8	-52312 85.0	-51220 86.9	-50128 88.6	-49049 89.9	-47993 90.7	-46973 91.2	-45998 91.1	-45078 90.7	-44220 90.0	-43430 89.1	-75
-80	-55204 87.6	-54675 88.5	-53733 89.4	-52985 90.2	-52237 90.8	-51495 91.3	-50766 91.7	-50056 91.9	-49370 91.9	-48715 91.8	-48096 91.6	-47513 91.3	-80
-85	-55061 89.7	-54686 90.1	-54305 90.4	-53920 90.7	-53535 90.9	-53152 91.1	-52775 91.3	-52405 91.4	-52047 91.5	-51701 91.5	-51371 91.5	-51060 91.5	-85
-90	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-90
LAT													LAT
E. LONG	240	245	250	255	260	265	270	275	280	285	290	295	E. LONG

VERTICAL COMPONENT (Z) WMM-90

E. LONG / LAT	300	305	310	315	320	325	330	335	340	345	350	355	LAT
0	9904 -125.7	8041 -145.4	5759 -159.3	3153 -167.1	353 -169.0	-2482 -165.4	-5191 -157.1	-7636 -144.8	-9721 -129.5	-11609 -112.3	-12710 -94.0	-13673 -75.5	0
-5	5301 -111.3	3547 -131.5	1369 -146.5	-1127 -155.8	-3811 -159.3	-6532 -157.4	-9143 -150.5	-11522 -139.5	-13592 -125.4	-15328 -109.2	-16750 -91.7	-17900 -77.6	-5
-10	1016 -98.8	-579 -116.9	-2575 -131.0	-4879 -140.7	-7332 -144.6	-9824 -143.9	-12220 -138.9	-14426 -128.9	-16386 -115.4	-18090 -100.3	-19554 -83.7	-20826 -66.2	-10
-15	-2842 -82.9	-4219 -100.4	-5983 -114.2	-8020 -123.7	-10201 -127.2	-12404 -126.3	-14529 -120.9	-16502 -111.7	-18290 -99.6	-19892 -85.3	-21326 -69.5	-22614 -52.5	-15
-20	-6202 -69.5	-7334 -85.0	-8839 -96.9	-10597 -104.4	-12488 -107.3	-14399 -105.7	-16247 -99.8	-17974 -90.4	-19559 -78.3	-21005 -64.2	-22325 -48.7	-23528 -32.1	-20
-25	-9077 -55.7	-9957 -69.1	-11199 -79.0	-12690 -84.7	-14312 -86.0	-15959 -82.8	-17556 -75.6	-19067 -65.7	-20619 -52.3	-21679 -37.7	-22810 -22.1	-23842 -5.9	-25
-30	-11563 -40.4	-12199 -51.9	-13190 -60.1	-14431 -64.0	-15808 -63.5	-17220 -58.5	-18587 -49.6	-19860 -37.5	-21016 -23.2	-22052 -7.6	-22875 8.4	-23786 24.2	-30
-35	-13829 -23.0	-14233 -33.1	-14982 -39.8	-15981 -42.3	-17121 -40.2	-18305 -33.5	-19451 -22.9	-20508 -9.2	-21448 6.6	-22266 25.1	-22967 39.5	-23555 54.6	-35
-40	-16090 -3.6	-16279 -12.7	-16776 -18.4	-17523 -19.9	-18414 -16.7	-19356 -9.0	-20271 2.8	-21106 17.5	-21833 34.1	-22445 51.1	-22948 67.3	-23352 81.4	-40
-45	-18573 16.6	-18532 8.5	-18788 3.4	-19268 2.5	-19888 6.0	-20568 14.0	-21236 25.8	-21842 40.5	-22365 56.7	-22795 73.2	-23141 88.4	-23417 101.0	-45
-50	-21479 35.9	-21225 28.8	-21229 24.5	-21433 23.7	-21770 26.9	-22174 34.2	-22589 44.9	-22975 58.2	-23309 72.9	-23588 87.5	-23820 100.9	-24022 111.6	-50
-55	-24937 52.9	-24490 47.0	-24259 43.3	-24201 42.5	-24266 45.0	-24408 50.8	-24586 59.5	-24765 70.5	-24936 82.2	-25092 94.2	-25244 104.9	-25405 113.3	-55
-60	-28962 66.4	-28361 61.9	-27935 59.0	-27655 58.2	-27489 59.7	-27405 63.7	-27377 69.8	-27386 77.8	-27421 86.2	-27481 94.8	-27572 102.6	-27708 108.7	-60
-65	-33436 76.4	-32738 73.3	-32179 71.2	-31762 70.4	-31406 71.1	-31155 73.4	-30975 77.0	-30854 81.8	-30786 87.1	-30792 92.6	-30816 97.5	-30926 101.4	-65
-70	-38113 81.4	-37399 81.6	-36788 80.2	-36274 79.5	-35847 79.6	-35502 80.6	-35232 82.3	-35032 84.6	-34900 87.4	-34836 90.2	-34844 92.8	-34928 94.9	-70
-75	-42710 88.1	-42064 87.2	-41490 86.4	-40990 86.0	-40560 85.8	-40201 86.0	-39911 86.5	-39689 87.3	-39536 88.3	-39452 89.4	-39439 90.4	-39502 91.2	-75
-80	-46974 90.9	-46469 90.6	-46034 90.3	-45637 89.6	-45291 89.8	-44998 89.7	-44758 89.7	-44572 89.8	-44442 89.9	-44370 90.1	-44355 90.2	-44399 90.3	-80
-85	-50768 91.5	-50502 91.4	-50255 91.3	-50036 91.2	-49844 91.2	-49681 91.1	-49548 91.0	-49446 90.9	-49375 90.8	-49337 90.7	-49332 90.6	-49360 90.4	-85
-90	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-54094 88.9	-90
LAT / E. LONG	300	305	310	315	320	325	330	335	340	345	350	355	LAT / E. LONG

HORIZONTAL COMPONENT (H) WMM-90

E. LONG LAT	0	5	10	15	20	25	30	35	40	45	50	55	E. LONG LAT
90	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	90
85	4636 -16.7	4652 -17.0	4651 -17.3	4632 -17.5	4597 -17.7	4544 -17.9	4475 -18.1	4369 -18.2	4287 -18.3	4170 -18.4	4037 -18.4	3891 -18.4	85
80	6891 -17.7	6925 -18.3	6932 -18.8	6912 -19.3	6864 -19.8	6790 -20.2	6687 -20.6	6555 -20.9	6393 -21.2	6202 -21.5	5981 -21.7	5731 -21.9	80
75	8948 -15.7	8993 -16.5	9009 -17.3	8997 -18.0	8957 -18.6	8886 -19.3	8784 -19.9	8648 -20.5	8477 -21.0	8266 -21.5	8015 -22.1	7742 -22.6	75
70	10927 -11.7	10970 -12.7	10988 -13.7	10982 -14.6	10953 -15.4	10900 -16.2	10820 -17.0	10709 -17.6	10565 -18.3	10382 -19.0	10156 -19.6	9863 -20.4	70
65	12957 -6.9	12983 -8.3	12990 -9.7	12980 -10.8	12957 -11.9	12919 -12.8	12866 -13.5	12794 -14.1	12698 -14.6	12573 -15.1	12411 -15.6	12208 -16.2	65
60	15131 -2.3	15131 -4.2	15116 -6.1	15092 -7.8	15063 -9.2	15032 -10.2	14999 -10.9	14963 -11.3	14919 -11.5	14861 -11.4	14783 -11.4	14677 -11.4	60
55	17486 2.2	17462 -.5	17424 -3.2	17381 -5.6	17340 -7.5	17307 -8.9	17284 -9.7	17273 -9.9	17271 -9.6	17275 -8.9	17280 -8.1	17279 -7.3	55
50	20007 6.8	19972 3.2	19922 -.4	19869 -3.6	19821 -6.3	19785 -8.2	19767 -9.2	19770 -9.3	19796 -8.7	19845 -7.6	19918 -6.1	20011 -4.6	50
45	22643 11.7	22619 7.3	22580 3.0	22536 -1.0	22497 -4.4	22471 -6.8	22462 -8.2	22476 -8.6	22515 -8.1	22591 -6.9	22710 -5.3	22875 -3.7	45
40	25313 16.8	25329 12.0	25327 7.2	25321 2.7	25316 -1.1	25318 -3.9	25329 -5.8	25353 -6.7	25401 -6.8	25488 -6.3	25632 -5.4	25843 -4.5	40
35	27906 21.3	27986 16.6	28049 11.9	28106 7.4	28160 3.6	28211 .4	28255 -2.0	28298 -3.7	28352 -4.9	28441 -5.6	28592 -6.1	28827 -6.6	35
30	30259 24.3	30423 20.1	30570 15.9	30707 12.0	30836 8.3	30948 5.1	31039 2.2	31108 -.4	31174 -2.9	31266 -5.2	31421 -7.5	31667 -9.6	30
25	32148 24.5	32406 21.3	32648 18.0	32875 14.8	33084 11.6	33262 8.5	33403 5.0	33509 1.4	33599 -2.2	33708 -6.0	33877 -9.6	34140 -13.0	25
20	33308 21.4	33663 19.3	34003 17.0	34322 14.4	34608 11.5	34850 8.2	35044 4.5	35196 .4	35328 -4.0	35478 -8.4	35686 -12.6	35989 -16.2	20
15	33498 14.7	33943 13.7	34377 12.2	34780 10.1	35137 7.3	35438 3.9	35685 .0	35894 -4.3	36091 -8.5	36313 -12.5	36598 -15.7	36973 -18.2	15
10	32583 4.7	33093 4.5	33601 3.6	34073 1.8	34488 -.9	34840 -4.3	35142 -8.0	35419 -11.6	35703 -14.7	36030 -16.9	36429 -18.0	36917 -17.8	10
5	30599 -8.3	31128 -7.6	31666 -8.0	32172 -9.5	32620 -11.8	33011 -14.6	33368 -17.4	33726 -19.5	34119 -20.5	34578 -19.9	35125 -17.8	35763 -14.2	5
0	27772 -23.5	28247 -22.1	28748 -21.7	29230 -22.3	29671 -23.5	30080 -24.8	30488 -25.6	30934 -25.3	31453 -23.3	32068 -19.4	32788 -13.7	33601 -6.6	0
LAT E. LONG	0	5	10	15	20	25	30	35	40	45	50	55	LAT E. LONG

nT
(units: nT)

HORIZONTAL COMPONENT (H) WMM-90

Each cell gives H, then its annual change.

E. LONG / LAT	60	65	70	75	80	85
90	2176 -13.6	2176 -13.6	2176 -13.6	2176 -13.6	2176 -13.6	2176 -13.6
85	3731 -18.3	3560 -18.2	3379 -18.1	3190 -18.0	2996 -17.9	2798 -17.7
80	5453 -22.0	5149 -22.1	4822 -22.1	4478 -22.1	4126 -22.0	3768 -21.9
75	7388 -23.1	7016 -23.5	6606 -24.0	6172 -24.4	5725 -24.7	5285 -25.0
70	9561 -21.2	9192 -22.0	8781 -22.9	8338 -23.9	7883 -24.8	7442 -25.7
65	11958 -16.9	11661 -17.9	11320 -19.0	10948 -20.4	10563 -21.9	10194 -23.4
60	14538 -11.7	14361 -12.2	14146 -13.2	13905 -14.6	13649 -16.4	13404 -18.4
55	17265 -6.7	17232 -6.8	17175 -7.1	17097 -8.3	17003 -10.1	16910 -12.4
50	20118 -3.4	20229 -2.7	20336 -2.6	20427 -3.4	20504 -5.1	20569 -7.4
45	23082 -2.3	23319 -1.4	23570 -1.2	23820 -1.9	24054 -3.3	24263 -5.5
40	26121 -1.7	26455 -3.2	26822 -3.4	27199 -4.1	27560 -5.5	27886 -7.5
35	29148 -7.0	29547 -7.7	29995 -8.6	30460 -9.7	30911 -11.1	31318 -12.7
30	32016 -11.5	32449 -13.4	32944 -15.1	33462 -16.6	33966 -17.8	34418 -18.8
25	34508 -16.0	34968 -18.6	35489 -20.6	36034 -21.9	36562 -22.7	37031 -22.8
20	36392 -19.2	36883 -21.3	37429 -22.7	37992 -23.2	38531 -22.9	39002 -21.9
15	37442 -19.7	37987 -20.2	38575 -19.9	39164 -18.8	39720 -17.1	40196 -14.8
10	37490 -16.6	38123 -14.5	38782 -11.8	39426 -8.8	40019 -5.6	40521 -2.2
5	36476 -9.6	37230 -4.5	37990 .5	38717 5.2	39377 9.5	39936 13.3
0	34478 .9	35374 8.3	36254 14.8	37083 20.3	37832 24.6	38477 27.9

E. LONG / LAT	90	95	100	105	110	115
90	2176 -13.6	2176 -13.6	2176 -13.6	2176 -13.6	2176 -13.6	2176 -13.6
85	2601 -17.5	2407 -17.3	2222 -17.1	2048 -16.9	1891 -16.6	1756 -16.2
80	3426 -21.6	3112 -21.3	2849 -20.7	2660 -19.8	2564 -18.5	2571 -16.9
75	4880 -25.0	4543 -24.7	4314 -23.9	4225 -22.7	4292 -21.1	4506 -19.8
70	7054 -26.3	6760 -26.5	6605 -26.3	6621 -25.6	6818 -24.6	7178 -23.5
65	9880 -24.8	9664 -25.9	9590 -26.6	9686 -26.8	9962 -26.7	10400 -26.3
60	13202 -20.6	13083 -22.7	13085 -24.4	13234 -25.7	13543 -26.5	13998 -26.8
55	16841 -15.1	16825 -17.9	16893 -20.5	17070 -22.7	17379 -24.2	17788 -25.0
50	20634 -10.3	20715 -13.5	20834 -16.5	21014 -19.1	21269 -20.9	21601 -21.8
45	24446 -8.3	24608 -11.3	24759 -14.1	24917 -16.4	25098 -17.8	25310 -18.2
40	28161 -9.8	28379 -12.2	28541 -14.2	28656 -15.4	28742 -15.7	28812 -14.9
35	31654 -14.3	31903 -15.5	32053 -16.1	32112 -15.8	32092 -14.4	32015 -12.0
30	34785 -19.3	35039 -19.2	35164 -18.2	35158 -16.2	35038 -13.0	34823 -8.9
25	37403 -22.1	37645 -20.6	37735 -18.1	37670 -14.8	37464 -10.3	37139 -4.9
20	39365 -20.0	39587 -17.3	39646 -13.9	39538 -9.7	39275 -4.8	38880 .5
15	40556 -12.0	40767 -8.7	40813 -5.1	40691 -1.2	40412 2.8	39997 6.9
10	40899 1.1	41128 4.5	41196 7.2	41102 9.6	40856 11.7	40474 13.4
5	40369 16.4	40657 18.7	40793 20.1	40778 20.5	40618 19.9	40325 18.5
0	38999 30.0	39387 30.9	39639 30.4	39751 28.5	39726 25.2	39568 20.9

HORIZONTAL COMPONENT (H) WMM-90

E. LONG / LAT	120	125	130	135	140	145	150	155	160	165	170	175	E. LONG / LAT
90	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	90
85	1947 -15.8	1566 -15.2	1516 -14.5	1490 -13.8	1488 -13.1	1503 -12.4	1528 -11.8	1557 -11.3	1583 -10.9	1603 -10.6	1612 -10.4	1609 -10.3	85
80	2675 -15.3	2853 -14.0	3082 -13.1	3336 -12.6	3592 -12.4	3840 -12.5	4066 -12.8	4262 -13.1	4422 -13.5	4542 -13.9	4618 -14.3	4651 -14.6	80
75	4838 -18.3	5247 -17.5	5696 -17.2	6153 -17.4	6593 -17.8	6999 -18.4	7357 -19.1	7658 -19.8	7895 -20.5	8067 -21.1	8170 -21.5	8205 -21.9	75
70	7663 -22.7	8227 -22.2	8826 -22.1	9421 -22.3	9982 -22.8	10486 -23.3	10920 -23.8	11274 -24.3	11544 -24.8	11728 -25.1	11827 -25.3	11843 -25.4	70
65	10965 -25.9	11607 -25.6	12278 -25.4	12933 -25.3	13538 -25.3	14069 -25.2	14511 -25.1	14856 -24.8	15104 -24.4	15259 -24.0	15326 -23.6	15306 -23.2	65
60	14569 -26.8	15209 -26.5	15868 -26.0	16499 -25.4	17065 -24.7	17542 -23.7	17918 -22.5	18189 -21.2	18360 -19.7	18442 -18.2	18443 -16.9	18374 -15.8	60
55	18297 -25.2	18860 -24.9	19427 -24.1	19953 -22.9	20402 -21.3	20752 -19.5	20994 -17.3	21132 -15.0	21177 -12.5	21145 -10.0	21052 -7.8	20912 -6.1	55
50	21995 -21.9	22418 -21.3	22828 -20.1	23184 -18.4	23453 -16.3	23617 -14.0	23674 -11.4	23633 -8.6	23514 -5.7	23337 -2.7	23123 .0	22891 2.2	50
45	25547 -17.7	25785 -16.5	25993 -14.8	26133 -12.8	26179 -10.8	26121 -8.7	25962 -6.5	25718 -4.2	25416 -1.9	25076 .6	24722 3.1	24381 5.5	45
40	28869 -13.3	28900 -11.1	28880 -8.9	28782 -6.9	28586 -5.3	28291 -4.3	27907 -3.6	27457 -3.0	26967 -2.3	26463 -1.3	25973 .1	25518 2.1	40
35	31689 -8.9	31711 -5.6	31463 -2.8	31128 -1.0	30696 -.4	30172 -.9	29577 -2.4	28936 -4.4	28279 -6.3	27633 -7.7	27021 -8.0	26465 -7.1	35
30	34531 -4.4	34163 -.1	33712 3.1	33166 4.8	32526 4.1	31807 1.8	31036 -2.0	30243 -6.7	29458 -11.5	28706 -15.5	28008 -18.1	27384 -18.6	30
25	36715 .5	36193 5.2	35587 8.4	34879 9.5	34086 8.2	33228 4.6	32340 -.9	31453 -7.6	30596 -14.7	29791 -21.1	29056 -25.9	28404 -28.1	25
20	38372 5.6	37762 9.9	37053 12.7	36251 13.3	35376 11.8	34456 7.8	33525 1.7	32617 -5.7	31755 -13.7	30959 -21.4	30239 -27.8	29604 -31.8	20
15	39462 10.6	38822 13.5	38086 15.2	37268 15.3	36392 13.6	35493 10.3	34601 5.4	33747 -.8	32949 -8.0	32220 -15.5	31565 -22.5	30984 -27.9	15
10	39974 14.6	39368 15.2	38675 15.2	37915 14.6	37116 13.5	36313 11.7	35532 9.2	34797 5.6	34120 .9	33506 -4.9	32951 -11.3	32451 -17.4	10
5	39914 16.6	39402 14.5	38811 12.6	38170 11.9	37508 10.6	36855 10.7	36234 11.1	35660 11.9	35138 10.8	34666 7.0	34233 2.3	33827 -3.7	5
0	39292 16.1	38918 11.4	38474 7.6	37991 5.4	37499 5.2	37026 8.9	36582 10.0	36182 13.5	35826 15.9	35500 16.2	35193 13.7	34884 8.5	0
LAT / E. LONG	120	125	130	135	140	145	150	155	160	165	170	175	LAT / E. LONG

HORIZONTAL COMPONENT (H) WMM-90

E. LONG	180	185	190	195	200	205	210	215	220	225	230	235	E. LONG
LAT													LAT
90	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	90
85	1591 -10.3	1558 -10.3	1508 -10.4	1443 -10.5	1366 -10.7	1272 -11.0	1170 -11.4	1065 -11.9	962 -12.6	874 -13.3	815 -13.9	803 -13.4	85
80	4638 -14.8	4579 -14.9	4475 -14.9	4326 -14.8	4134 -14.6	3901 -14.2	3628 -13.8	3318 -13.3	2973 -12.7	2597 -12.1	2163 -11.5	1768 -10.8	80
75	8171 -22.1	8070 -22.2	7902 -22.1	7669 -21.9	7373 -21.5	7016 -20.9	6600 -20.1	6127 -19.1	5602 -17.8	5029 -16.2	4412 -14.4	3757 -12.3	75
70	11779 -25.5	11836 -25.5	11612 -25.4	11313 -25.1	10737 -24.7	10286 -24.1	9760 -23.2	9163 -21.9	8497 -20.2	7769 -18.1	6982 -15.4	6159 -12.1	70
65	15208 -22.9	15032 -22.8	14780 -22.8	14449 -22.8	14039 -22.8	13547 -22.6	12972 -22.0	12314 -21.0	11577 -19.2	10766 -16.8	9889 -13.5	8960 -9.5	65
60	18241 -15.1	18046 -14.9	17790 -15.1	17468 -15.6	17076 -16.4	16606 -17.0	16054 -17.3	15419 -16.9	14693 -15.7	13889 -13.5	13013 -10.3	12077 -6.2	60
55	20735 -4.9	20525 -4.5	20281 -4.9	19998 -6.0	19665 -7.6	19272 -9.3	18808 -10.6	18265 -11.6	17639 -11.4	16931 -10.1	16146 -7.6	15293 -4.1	55
50	22654 3.8	22420 4.5	22188 4.2	21952 2.9	21700 .8	21416 -1.8	21083 -4.4	20688 -6.5	20220 -7.7	19674 -7.7	19049 -6.5	18349 -4.2	50
45	24067 7.4	23792 8.7	23559 9.1	23363 8.3	23192 6.4	23026 3.6	22838 .4	22611 -2.7	22328 -5.1	21976 -6.7	21548 -7.3	21041 -8.6	45
40	25118 4.3	24790 6.4	24542 8.0	24372 9.6	24266 8.0	24201 6.2	24150 3.4	24084 .1	23978 -3.3	23817 -6.3	23589 -8.7	23265 -10.3	40
35	25988 -4.9	25608 -1.8	25337 1.5	25178 4.3	25117 6.1	25131 6.3	25185 5.0	25248 2.2	25290 -1.6	25292 -5.9	25238 -10.3	25119 -14.4	35
30	26853 -16.9	26435 -13.2	26144 -8.2	25986 -2.9	25959 1.7	26009 4.6	26131 5.4	26278 5.9	26422 .2	26543 -5.1	26625 -11.5	26655 -18.3	30
25	27852 -27.4	27417 -23.7	27119 -17.7	26850 -10.5	26915 -3.5	26986 2.0	27129 4.9	27312 4.8	27507 1.5	27697 -4.6	27865 -12.6	27997 -21.8	25
20	29063 -32.6	28631 -29.0	28322 -24.1	28141 -16.5	28082 -8.4	28126 -1.5	28244 2.8	28419 1.7	28603 .8	28806 -5.8	29006 -14.8	29185 -25.7	20
15	30480 -30.5	30064 -29.9	29747 -26.0	29535 -19.8	29425 -12.6	29403 -6.1	29452 -1.8	29552 -.7	29688 -3.4	29848 -9.7	30019 -19.1	30184 -30.2	15
10	32001 -21.9	31606 -24.1	31276 -23.6	31016 -20.7	30831 -16.5	30713 -12.4	30656 -9.6	30648 -9.1	30680 -11.6	30743 -17.2	30828 -25.5	30921 -35.4	10
5	33438 -9.9	33065 -15.2	32716 -18.6	32401 -20.6	32127 -20.8	31899 -20.4	31717 -20.1	31576 -20.7	31472 -22.9	31401 -27.1	31357 -33.0	31334 -40.1	5
0	34557 1.4	34208 -6.6	33844 -14.2	33477 -20.7	33123 -25.7	32791 -29.2	32489 -31.6	32218 -33.7	31974 -34.8	31758 -36.7	31570 -39.3	31413 -42.4	0
LAT													LAT
E. LONG	180	185	190	195	200	205	210	215	220	225	230	235	E. LONG

HORIZONTAL COMPONENT (H) WMM-90

E. LONG LAT	240	245	250	255	260	265	270	275	280	285	290	295	E. LONG LAT
90	2176 -13.6	2176 -13.6	2176 -13.6	2176 -13.6	2176 -13.6	2176 -13.6	2176 -13.6	2176 -13.6	2176 -13.6	2176 -13.6	2176 -13.6	2176 -13.6	90
85	848 -13.3	949 -12.2	1094 -11.2	1272 -10.4	1471 -9.9	1684 -9.7	1904 -9.7	2129 -9.8	2355 -10.0	2578 -10.3	2796 -10.7	3008 -11.1	85
80	1320 -10.6	864 -11.2	430 -14.6	306 -13.1	704 -4.0	1180 -2.8	1666 -2.6	2147 -3.2	2619 -4.1	3076 -5.0	3515 -6.0	3933 -7.0	80
75	3073 -9.7	2369 -6.4	1664 -1.5	1011 7.7	661 23.0	1016 20.0	1668 13.8	2370 9.7	3069 6.8	3747 4.5	4394 2.4	5004 .5	75
70	5295 -8.0	4425 -3.0	3582 3.4	2835 11.9	2318 22.1	2218 29.1	2576 28.7	3231 24.8	4019 20.7	4822 17.1	5622 14.0	6383 11.2	70
65	7999 -4.7	7035 1.0	6111 7.6	5297 15.1	4691 23.0	4608 29.7	4516 33.3	4977 33.3	5676 31.4	6498 28.6	7358 25.7	8202 22.7	65
60	11103 -1.4	10120 4.0	9172 9.6	8323 16.1	7651 22.3	7254 28.1	7189 32.7	7466 35.5	8026 36.[illegible]	8772 36.1	9612 34.7	10469 32.5	60
55	14389 .0	13461 4.6	12546 9.3	11702 14.1	10897 18.9	10513 23.9	10315 28.9	10432 33.5	10841 37.1	11672 39.4	12239 40.2	13057 39.5	55
50	17584 -1.3	16773 1.9	15946 5.2	15150 8.6	14648 12.4	139[illegible]3 16.9	13615 22.3	13597 28.4	13860 34.4	14361 39.4	15025 42.6	15771 43.8	50
45	20459 -5.4	19809 -3.9	19114 -2.1	18411 .0	17753 3.0	1720[illegible] 7.2	16846 13.2	16720 20.8	16850 29.0	17217 36.6	17764 42.3	18419 45.4	45
40	22900 -11.4	22435 -11.9	21901 -11.9	21323 -11.2	20764 -9.0	20224 -4.9	19830 1.8	19622 10.8	19635 21.1	19870 31.1	20294 39.3	20846 44.5	40
35	24923 -18.1	24641 -21.2	24273 -23.3	23832 -24.1	23349 -22.8	22874 -18.8	22470 -11.8	22198 -1.4	22107 10.7	22217 22.9	22513 33.3	22955 40.6	35
30	26617 -24.9	26495 -30.7	26275 -35.2	25959 -37.6	25566 -37.4	25135 -33.7	24724 -26.2	24397 -15.2	24211 -1.9	24200 12.0	24370 24.3	24698 35.5	30
25	28073 -31.1	28068 -39.5	27960 -46.2	27738 -50.4	27409 -51.2	27006 -48.1	26581 -40.9	26199 -29.7	25922 -15.6	25798 -1.1	25848 12.5	26063 23.2	25
20	29320 -36.8	29381 -47.1	29338 -55.4	29171 -60.7	28878 -62.8	28484 -60.3	28036 -53.7	27598 -43.1	27238 -29.6	27012 -14.9	26951 -.9	27062 10.6	20
15	30319 -41.9	30392 -52.6	30370 -61.3	30226 -67.2	29949 -69.7	29555 -68.2	29084 -62.7	28599 -53.5	28168 -41.3	27853 -27.7	27697 -14.4	27716 -3.0	15
10	31001 -45.7	31041 -55.3	31005 -63.1	30564 -68.6	30598 -71.1	30210 -70.5	29731 -66.5	29215 -59.1	28730 -49.2	28344 -37.7	28104 -26.1	28035 -15.8	10
5	31319 -47.4	31291 -54.3	31221 -60.0	31075 -64.2	30824 -66.5	30458 -66.8	29990 -64.3	29464 -59.4	28944 -52.2	28499 -43.6	28186 -34.6	28028 -26.5	5
0	31283 -45.7	31171 -49.0	31054 -52.0	30896 -54.8	30663 -56.5	30327 -57.4	29885 -56.9	29366 -54.7	28824 -50.8	28328 -45.5	27938 -39.7	27687 -34.2	0
LAT E. LONG	240	245	250	255	260	265	270	275	280	285	290	295	LAT E. LONG

HORIZONTAL COMPONENT (H) WMM-90

E. LONG	300	305	310	315	320	325	330	335	340	345	350	355	E. LONG
LAT													LAT
90	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	2174 -13.6	90
85	3212 -11.5	3406 -12.0	3590 -12.4	3761 -12.9	3919 -13.4	4063 -13.9	4192 -14.3	4306 -14.8	4405 -15.2	4488 -15.6	4556 -16.0	4603 -16.3	85
80	4328 -8.0	4697 -9.0	5039 -9.9	5353 -10.9	5638 -11.8	5894 -12.7	6121 -13.5	6319 -14.3	6489 -15.1	6631 -15.8	6745 -16.5	6831 -17.1	80
75	5572 -1.2	6095 -2.9	6570 -4.4	6998 -5.9	7379 -7.3	7713 -8.6	8003 -9.8	8251 -11.0	8460 -12.0	8631 -13.0	8769 -14.0	8873 -14.9	75
70	7090 8.6	7735 6.2	8313 4.0	8923 1.9	9266 -.1	9646 -2.0	9966 -3.7	10232 -5.3	10449 -6.8	10622 -8.1	10756 -9.4	10857 -10.6	70
65	8896 19.7	9718 16.7	10358 13.8	10913 11.0	11385 8.3	11779 5.8	12101 3.5	12359 1.5	12561 -.5	12716 -2.2	12829 -3.9	12907 -5.4	65
60	11290 29.8	12041 26.6	12703 23.3	13269 20.0	13742 16.7	14126 13.7	14432 11.0	14669 8.5	14846 6.1	14974 4.0	15059 1.9	15109 -.2	60
55	13859 37.6	14600 34.8	15253 31.4	15807 27.8	16263 24.2	16628 20.9	16913 17.9	17130 15.2	17288 12.6	17396 10.1	17461 7.6	17488 4.9	55
50	16526 43.0	17233 40.7	17861 37.6	18396 34.0	18832 30.5	19183 27.3	19459 24.3	19670 21.7	19826 19.1	19933 16.4	19995 13.5	20018 10.3	50
45	19107 46.0	19770 44.6	20370 42.0	20887 38.8	21320 35.7	21677 32.8	21967 30.3	22199 27.8	22380 25.4	22511 22.8	22596 19.5	22638 15.8	45
40	21659 46.6	22073 46.3	22648 44.5	23163 42.1	23616 39.6	24006 37.4	24340 35.4	24625 33.4	24861 31.2	25046 28.5	25180 25.2	25267 21.3	40
35	23485 44.5	24049 45.3	24606 44.8	25134 43.3	25625 41.7	26077 40.5	26488 38.9	26856 37.4	27173 35.5	27436 32.9	27642 29.7	27796 25.8	35
30	25140 39.1	25652 41.7	26195 42.2	26745 41.8	27289 41.1	27817 40.5	28319 39.7	28781 38.6	29192 37.0	29542 34.7	29832 31.7	30067 28.2	30
25	26417 30.4	26874 34.4	27399 36.2	27967 36.8	28557 37.0	29150 36.9	29727 36.7	30267 35.9	30754 34.6	31180 32.7	31548 30.3	31866 27.5	25
20	27330 18.9	27728 24.0	28226 26.8	28786 28.1	29387 28.8	29998 29.1	30595 29.1	31156 28.7	31669 27.8	32133 26.5	32550 25.0	32939 23.3	20
15	27899 5.6	28229 11.2	28670 14.5	29184 16.1	29734 16.8	30285 17.0	30814 17.1	31308 16.9	31767 16.6	32201 16.2	32626 15.8	33057 15.4	15
10	28136 -7.9	28379 -2.5	28728 .5	29137 1.8	29558 2.1	29957 1.9	30318 1.7	30646 1.6	30963 1.9	31296 2.5	31670 3.3	32101 4.2	10
5	28031 -20.1	28163 -15.8	28379 -13.7	28623 -13.2	28843 -13.9	29011 -14.9	29125 -15.7	29212 -15.8	29315 -15.1	29484 -13.7	29751 -11.7	30128 -9.8	5
0	27574 -30.0	27568 -27.4	27614 -26.7	27651 -27.6	27629 -29.5	27528 -31.7	27342 -33.5	27177 -33.9	27037 -33.2	27004 -31.3	27116 -28.7	27380 -25.9	0
LAT													LAT
E. LONG	300	305	310	315	320	325	330	335	340	345	350	355	E. LONG

HORIZONTAL COMPONENT (H) WMM-90

E. LONG / LAT	0	5	10	15	20	25	30	35	40	45	50	55	E. LONG / LAT
0	27772 -23.5	28247 -22.1	28748 -21.7	29230 -22.9	29671 -23.5	30080 -24.8	30488 -25.6	30934 -25.4	31453 -23.3	32068 -19.4	32788 -15.7	33601 -8.6	0
-5	24469 -40.5	24803 -38.0	25193 -36.2	25570 -34.9	25954 -33.9	26353 -32.5	26803 -30.4	27340 -26.9	27993 -21.5	28776 -14.2	29680 -5.3	30676 4.3	-5
-10	21095 -57.9	21217 -54.1	21401 -50.2	21630 -46.0	21913 -41.5	22277 -36.5	22756 -30.5	23382 -23.3	24170 -14.6	25118 -4.4	26200 6.6	27364 17.2	-10
-15	17299 -74.3	17877 -68.4	17635 -62.2	17881 -54.4	18046 -45.8	18365 -36.4	18869 -26.4	19577 -15.5	20490 -3.8	21586 8.3	22816 19.8	24107 29.4	-15
-20	15406 -87.1	15071 -79.8	14834 -70.4	14729 -59.1	14803 -46.4	15096 -33.0	15633 -19.3	16419 -4.4	17439 8.4	18649 21.0	19973 31.2	21320 37.9	-20
-25	13420 -94.3	12958 -85.1	12616 -73.2	12443 -59.0	12494 -43.3	12807 -27.0	13399 -10.7	14264 4.9	15365 19.1	16635 30.5	17978 37.7	19293 40.0	-25
-30	12075 -94.5	11597 -83.5	11264 -69.7	11127 -53.8	11237 -36.6	11626 -18.1	12294 -2.2	13227 13.5	14368 25.9	15631 34.1	16911 37.1	18105 34.8	-30
-35	11385 -87.5	10989 -75.1	10759 -60.5	10738 -44.3	10963 -27.4	11451 -10.6	12197 4.9	13165 18.0	14289 27.2	15475 31.4	16620 30.0	17634 23.7	-35
-40	11361 -74.2	11101 -61.6	11017 -47.4	11137 -32.3	11481 -17.2	12053 -3.0	12834 9.3	13780 18.6	14822 23.7	15871 23.8	16837 19.1	17644 10.2	-40
-45	11982 -57.0	11860 -45.1	11908 -32.6	12138 -19.9	12556 -7.9	13154 2.6	13905 10.9	14764 16.1	15665 17.3	16536 14.4	17303 7.7	17905 -1.8	-45
-50	13152 -38.7	13130 -28.6	13256 -18.5	13533 -9.0	13955 -.6	14508 6.1	15163 10.5	15878 12.1	16600 10.7	17272 6.1	17837 -.9	18246 -9.5	-50
-55	14683 -22.6	14707 -14.6	14849 -7.2	15105 -.8	15466 4.3	15915 7.8	16424 9.3	16962 8.6	17487 5.6	17956 1.1	18327 -5.0	18562 -11.6	-55
-60	16317 -10.9	16339 -5.0	16448 .0	16637 4.0	16896 6.8	17207 8.2	17552 8.1	17903 6.8	18233 3.7	18509 -.1	18702 -4.4	18783 -8.6	-60
-65	17776 -4.3	17772 -.2	17825 3.2	17927 5.7	18071 7.2	18242 7.7	18426 7.3	18605 8.0	18758 4.1	18864 1.9	18902 -.5	18851 -2.6	-65
-70	18822 -1.6	18787 1.2	18786 3.6	18803 5.3	18843 6.4	18892 7.0	18939 7.0	18974 6.6	18983 6.0	18951 5.3	18866 4.6	18714 4.2	-70
-75	19282 -.3	19224 1.6	19176 3.3	19135 4.7	19096 5.8	19053 6.7	19001 7.3	18932 7.8	18839 8.2	18716 8.6	18549 9.1	18337 9.7	-75
-80	19045 2.2	18980 3.4	18911 4.6	18837 5.6	18755 6.7	18663 7.6	18557 8.6	18436 9.5	18297 10.4	18135 11.3	17948 12.2	17736 13.2	-80
-85	18051 7.5	18001 8.1	17943 8.7	17876 9.4	17800 9.9	17715 10.6	17621 11.2	17516 11.9	17401 12.6	17275 13.3	17139 14.1	16992 14.8	-85
-90	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	-90
LAT / E. LONG	0	5	10	15	20	25	30	35	40	45	50	55	LAT / E. LONG

HORIZONTAL COMPONENT (H) WMM-90

E. LONG / LAT	60	65	70	75	80	85	90	95	100	105	110	115	E. LONG / LAT
0	34476 .9	35374 8.3	36254 14.8	37083 20.3	37832 24.6	38477 27.9	38999 30.0	39387 30.9	39639 30.4	39753 28.5	39726 25.2	39568 20.9	0
-5	31718 13.6	32757 21.7	33755 28.2	34684 32.9	35523 36.0	36260 37.8	36886 38.3	37398 37.5	37794 35.2	38068 31.4	38212 26.2	38223 19.8	-5
-10	28550 36.2	29702 35.1	30785 37.6	31780 40.0	32678 40.8	33480 40.3	34190 38.9	34816 36.6	35355 33.1	35796 28.4	36118 22.4	36312 15.4	-10
-15	25384 36.1	26590 39.8	27696 40.7	28692 39.6	29585 37.4	30389 34.6	31126 31.5	31816 28.3	32455 24.5	33031 20.1	33514 14.8	33878 8.8	-15
-20	22609 40.6	23786 39.7	24825 38.2	25736 31.4	26537 26.3	27256 21.7	27932 17.8	28596 14.5	29261 11.6	29908 8.6	30501 5.3	31000 1.5	-20
-25	20497 37.8	21547 32.2	22433 24.6	23169 16.7	23785 9.8	24324 4.4	24837 .8	25374 -1.4	25960 -2.6	26587 -3.4	27213 -4.1	27788 -5.0	-25
-30	19142 28.0	19890 18.5	20648 8.2	21138 -1.5	21496 -8.7	21774 -15.4	22032 -15.7	22338 -16.1	22737 -15.1	23235 -13.5	23798 -11.6	24372 -9.8	-30
-35	18456 13.7	19064 2.0	19462 -9.3	19676 -18.6	19740 -25.0	19708 -28.0	19648 -28.3	19637 -26.6	19745 -23.7	20001 -20.2	20393 -16.6	20869 -13.0	-35
-40	18244 -1.1	18617 -13.0	18769 -23.5	18718 -31.3	18598 -35.7	18153 -36.6	17750 -34.8	17372 -31.5	17105 -27.1	17012 -23.0	17113 -18.9	17381 -15.1	-40
-45	18301 -12.6	18472 -23.0	18418 -31.5	18149 -36.9	17688 -38.9	17070 -37.8	16348 -34.4	15600 -30.0	14916 -25.6	14387 -22.0	14076 -19.2	14005 -16.8	-45
-50	18466 -18.4	18475 -26.3	18266 -32.1	17839 -35.0	17205 -34.9	16385 -32.3	15416 -28.0	14355 -23.4	13280 -19.6	12284 -17.3	11466 -16.9	10907 -17.6	-50
-55	18632 -17.9	18515 -23.0	18197 -26.1	17671 -26.8	16939 -25.3	16008 -21.9	14899 -17.5	13646 -13.2	12297 -10.0	10920 -8.8	9602 -10.3	8451 -14.4	-55
-60	18226 -12.3	18512 -14.8	18124 -15.8	17553 -15.2	16792 -12.9	15844 -9.4	14717 -5.4	13427 -1.5	11999 1.5	10467 2.8	8874 1.8	7277 -2.0	-60
-65	18691 -4.1	18406 -4.7	17983 -4.3	17610 -2.9	16683 -.5	15800 2.7	14764 6.1	13586 9.5	12275 12.4	10853 14.5	9340 15.5	7762 15.3	-65
-70	18481 4.2	18156 4.7	17731 5.8	17198 7.5	16553 9.7	15795 12.3	14928 15.1	13959 17.9	12897 20.5	11757 22.9	10558 25.0	9323 26.8	-70
-75	18072 10.6	17747 11.6	17358 13.0	16902 14.6	16378 16.4	15786 18.4	15130 20.5	14417 22.6	13654 24.8	12853 26.8	12028 28.8	11195 30.7	-75
-80	17490 14.2	17214 15.4	16906 16.6	16566 17.9	16194 19.2	15792 20.6	15364 22.1	14913 23.5	14446 25.0	13967 26.5	13487 27.7	13012 28.9	-80
-85	16835 15.5	16668 16.3	16491 17.1	16305 17.9	16112 18.6	15913 19.3	15709 20.1	15503 20.8	15296 21.5	15092 22.1	14892 22.7	14700 23.3	-85
-90	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	-90
LAT / E. LONG	60	65	70	75	80	85	90	95	100	105	110	115	LAT / E. LONG

HORIZONTAL COMPONENT (H) WMM-90

E. LONG / LAT	120	125	130	135	140	145	150	155	160	165	170	175	E. LONG / LAT
0	39292 16.1	38918 11.4	38474 7.6	37991 5.4	37499 5.2	37026 6.9	36582 10.0	36182 13.5	35624 15.9	35500 16.2	35193 13.7	34884 8.5	0
-5	38113 13.0	37905 6.5	37629 1.3	37320 -1.7	37006 -1.9	36709 .5	36440 5.5	36203 11.3	35997 16.4	35810 19.5	35622 19.2	35407 15.3	-5
-10	36381 8.0	36347 .9	36243 -4.8	36104 -8.2	35957 -8.8	35820 -6.4	35701 -1.4	35605 4.9	35529 11.2	35460 15.7	35378 17.1	35253 14.7	-10
-15	34119 2.4	34252 -3.9	34309 -9.2	34322 -12.8	34319 -14.0	34317 -12.7	34324 -9.1	34344 -3.9	34377 1.7	34411 6.2	34424 8.4	34389 7.3	-15
-20	31386 -2.7	31665 -6.9	31861 -11.0	32005 -14.2	32123 -16.1	32233 -16.5	32345 -15.1	32466 -12.5	32595 -9.0	32722 -5.8	32829 -3.7	32888 -3.7	-20
-25	28277 -6.2	28670 -8.0	28981 -10.1	29236 -12.5	29455 -14.9	29666 -16.9	29872 -18.1	30066 -18.[illegible]	30307 -17.7	30527 -16.4	30729 -15.1	30889 -14.5	-25
-30	24905 -8.3	25372 -7.6	25770 -7.8	26117 -9.1	26432 -11.5	26735 -14.5	27039 -17.4	27350 -20.0	27667 -21.8	27986 -22.5	28287 -22.2	28554 -21.4	-30
-35	21376 -9.7	21864 -7.1	22326 -5.7	22749 -5.7	23157 -7.5	23561 -10.2	23970 -13.9	24388 -17.7	24812 -20.6	25235 -22.9	25645 -23.5	26025 -22.9	-35
-40	17765 -11.5	18215 -8.2	18695 -5.8	19190 -4.6	19695 -4.9	20213 -6.7	20746 -9.6	21266 -13.0	21833 -16.2	22374 -18.6	22899 -19.8	23395 -19.8	-40
-45	14152 -14.5	14476 -11.9	14923 -9.3	15461 -7.1	16062 -5.8	16708 -5.7	17382 -6.6	18070 -8.5	18757 -10.3	19432 -12.2	20083 -13.7	20699 -14.5	-45
-50	10655 -18.4	10711 -18.1	11035 -16.3	11570 -13.6	12256 -10.5	13035 -7.9	13868 -6.2	14721 -5.6	15569 -5.8	16392 -6.8	17178 -8.2	17918 -9.8	-50
-55	7588 -19.8	7129 -24.3	7130 -25.4	7549 -22.8	8275 -17.9	9188 -12.7	10193 -8.3	11225 -5.3	12266 -3.9	13226 -3.9	14151 -5.2	15019 -7.4	-55
-60	5755 -9.1	4665 -19.5	3596 -30.5	3514 -33.1	4175 -25.7	5239 -16.6	6445 -9.5	7672 -5.0	8865 -2.8	9997 -2.5	11060 -3.8	12050 -6.5	-60
-65	6142 14.1	4504 12.1	2872 9.9	1268 9.4	338 17.1	1822 4.8	3263 5.1	4632 5.4	5925 4.8	7149 3.2	8279 .7	9346 -2.7	-65
-70	8079 28.6	6862 30.5	5720 33.0	4728 36.3	4009 39.7	3673 40.8	3819 37.6	4351 31.8	5116 25.6	5990 19.9	6913 14.8	7840 10.0	-70
-75	10376 32.5	9592 34.2	8872 35.8	8243 37.2	7737 38.5	7380 38.8	7192 38.4	7181 37.0	7338 34.7	7642 31.7	8067 28.3	8585 24.6	-75
-80	12553 30.1	12120 31.1	11726 32.0	11374 32.7	11080 33.1	10850 33.3	10691 33.2	10607 32.8	10599 32.1	10667 31.1	10807 29.8	11013 28.3	-80
-85	14518 23.8	14349 24.2	14195 24.6	14060 24.8	13946 25.0	13853 25.1	13785 25.0	13743 24.9	13727 24.7	13737 24.4	13773 24.0	13835 23.5	-85
-90	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	-90
LAT / E. LONG	120	125	130	135	140	145	150	155	160	165	170	175	LAT / E. LONG

HORIZONTAL COMPONENT (H) WMM-90

E. LONG / LAT	180	185	190	195	200	205	210	215	220	225	230	235	E. LONG / LAT
0	34557 1.4	34208 -6.6	33844 -14.2	33477 -20.7	33123 -25.7	32791 -29.2	32489 -31.6	32218 -33.7	31976 -34.8	31758 -36.7	31570 -39.3	31413 -42.4	0
-5	35145 8.1	34828 -1.3	34463 -11.7	34066 -21.7	33656 -30.4	33251 -37.0	32861 -41.3	32488 -43.3	32133 -43.6	31796 -42.9	31482 -41.7	31201 -40.5	-5
-10	35062 8.4	34796 -.9	34454 -12.1	34062 -23.5	33639 -33.7	33207 -41.5	32779 -46.3	32358 -47.8	31944 -46.4	31537 -42.9	31143 -38.3	30775 -33.5	-10
-15	34280 2.7	34084 -4.9	33804 -14.6	33458 -24.8	33073 -34.1	32669 -41.1	32261 -44.8	31853 -44.8	31446 -41.6	31029 -35.9	30611 -28.8	30202 -21.7	-15
-20	32875 -6.2	32774 -11.1	32588 -17.6	32333 -24.7	32031 -31.1	31707 -35.5	31372 -36.9	31032 -35.1	30682 -30.3	30314 -23.2	29925 -15.2	29519 -7.5	-20
-25	30985 -14.9	31001 -16.7	30937 -19.4	30806 -22.5	30626 -25.1	30418 -26.2	30195 -25.1	29958 -21.6	29703 -15.8	29418 -8.5	29094 -.8	28728 6.0	-25
-30	28768 -20.4	28916 -19.7	28989 -19.2	29001 -18.8	28964 -18.0	28892 -16.2	28796 -13.2	28679 -8.7	28536 -2.2	28349 3.7	28112 10.1	27817 15.1	-30
-35	26360 -21.5	26639 -19.5	26855 -17.2	27013 -14.8	27120 -12.1	27186 -8.9	27219 -5.1	27221 -.6	27188 4.5	27110 9.7	26976 14.4	26778 17.6	-35
-40	23850 -18.8	24255 -17.1	24606 -14.8	24897 -12.3	25137 -9.6	25331 -6.7	25485 -3.4	25602 .2	25680 4.0	25716 7.9	25701 11.0	25630 13.1	-40
-45	21271 -14.7	21793 -14.3	22261 -13.6	22673 -12.7	23031 -11.5	23342 -10.1	23609 -8.4	23840 -6.2	24036 -3.7	24198 -1.0	24324 1.6	24408 3.6	-45
-50	18606 -11.4	19238 -13.0	19814 -14.5	20334 -15.8	20802 -16.9	21224 -17.5	21607 -17.4	21960 -16.6	22289 -15.0	22597 -12.7	22884 -9.9	23145 -7.1	-50
-55	15823 -10.3	16566 -13.5	17249 -16.9	17877 -20.2	18458 -23.0	18999 -25.1	19511 -26.2	20003 -26.1	20482 -24.7	20952 -22.2	21411 -18.8	21853 -15.2	-55
-60	12970 -10.1	13826 -14.2	14619 -18.4	15365 -22.5	16069 -25.9	16743 -28.4	17397 -29.7	18038 -29.5	18673 -28.0	19303 -25.2	19926 -21.6	20527 -17.6	-60
-65	10348 -6.6	11291 -10.7	12186 -14.8	13037 -18.5	13858 -21.5	14656 -23.5	15439 -24.3	16211 -24.0	16976 -22.5	17726 -20.1	18462 -17.3	19173 -14.0	-65
-70	8761 5.5	9467 1.4	10554 -2.3	11625 -5.4	12280 -7.9	13322 -9.5	13852 -10.4	14771 -10.5	15577 -9.9	16365 -8.7	17128 -7.3	17860 -5.9	-70
-75	9171 21.0	9807 17.6	10478 14.5	11172 11.6	11881 9.5	12598 7.6	13316 6.2	14036 5.2	14741 4.5	15433 4.0	16105 3.7	16749 3.4	-75
-80	11279 26.7	11597 25.0	11959 23.2	12358 21.5	12786 19.8	13237 18.3	13702 16.6	14177 15.4	14655 14.1	15131 12.9	15598 11.7	16053 10.5	-80
-85	13922 23.0	14032 22.3	14163 21.7	14313 21.1	14481 20.1	14663 19.3	14857 18.5	15060 17.7	15271 16.8	15485 15.9	15702 15.1	15918 14.2	-85
-90	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	-90
LAT / E. LONG	180	185	190	195	200	205	210	215	220	225	230	235	LAT / E. LONG

HORIZONTAL COMPONENT (H) WMM-90

E. LONG / LAT	240	245	250	255	260	265	270	275	280	285	290	295	LAT / E. LONG
0	31283 -45.7	31171 -49.6	31056 -52.0	30896 -54.5	30663 -56.5	30327 -57.4	29885 -56.9	29366 -54.7	28826 -50.8	28328 -45.5	27978 -39.7	27687 -34.2	0
-5	30961 -39.7	30761 -36.4	30586 -39.8	30405 -41.0	30177 -42.8	29864 -44.8	29448 -46.5	28940 -47.1	28381 -46.4	27835 -44.5	27365 -41.9	27008 -39.5	-5
-10	30449 -29.3	30163 -26.3	29920 -25.1	29694 -25.8	29445 -28.2	29131 -31.7	28722 -35.6	28216 -39.0	27634 -41.4	27039 -42.6	26487 -42.9	26020 -42.8	-10
-15	29814 -15.7	29462 -11.7	29165 -10.2	28852 -11.5	28550 -15.2	28202 -20.7	27773 -27.0	27248 -33.1	26641 -38.1	25996 -41.8	25368 -44.3	24800 -46.2	-15
-20	29108 -1.4	28705 2.1	28320 2.5	27949 -.4	27576 -6.2	27169 -13.9	26698 -22.5	26142 -30.8	25505 -37.9	24818 -43.5	24128 -47.5	23478 -50.6	-20
-25	28329 10.8	27907 12.6	27477 11.0	27045 5.9	26605 -2.0	26140 -11.8	25624 -22.3	25036 -32.4	24376 -40.9	23657 -47.7	22926 -52.7	22220 -56.3	-25
-30	27466 18.0	27068 17.7	26639 14.1	26189 7.3	25720 -2.2	25224 -13.4	24683 -25.1	24079 -36.2	23407 -45.8	22680 -53.5	21930 -58.8	21192 -62.7	-30
-35	26617 18.7	26197 17.1	25829 12.3	25423 4.7	24984 -5.3	24507 -16.9	23980 -28.9	23390 -40.4	22733 -50.3	22019 -58.3	21271 -64.1	20524 -68.2	-35
-40	25500 13.5	25311 11.6	25067 7.1	24771 .0	24625 -9.2	24026 -20.0	23559 -31.5	23022 -42.2	22412 -52.5	21737 -60.6	21017 -66.7	20278 -71.2	-40
-45	24445 4.5	24430 3.8	24357 .5	24223 -4.8	24020 -12.3	23743 -21.5	23385 -31.6	22940 -41.8	22410 -51.2	21803 -59.2	21136 -65.6	20429 -70.3	-45
-50	23371 -5.1	23551 -4.3	23672 -5.3	23727 -8.5	23691 -13.8	23568 -20.9	23347 -29.2	23025 -38.0	22604 -46.5	22095 -54.1	21510 -60.4	20865 -65.3	-50
-55	22267 -11.9	22636 -9.6	22944 -8.9	23175 -10.2	23314 -13.4	23351 -18.5	23280 -25.0	23098 -32.1	22810 -39.4	22422 -46.2	21948 -52.1	21401 -57.0	-55
-60	21099 -13.9	21623 -11.1	22086 -9.7	22464 -9.9	22749 -11.8	22931 -15.2	23002 -20.0	22962 -25.5	22814 -31.4	22566 -37.1	22226 -42.2	21808 -46.6	-60
-65	19846 -11.1	20467 -8.9	21023 -7.7	21501 -7.7	21889 -9.0	22180 -11.5	22370 -14.9	22456 -19.0	22443 -23.5	22336 -27.9	22146 -32.0	21877 -35.5	-65
-70	18551 -4.6	19191 -3.8	19771 -3.6	20281 -4.2	20715 -5.4	21067 -7.4	21335 -9.9	21518 -12.8	21618 -16.0	21639 -19.1	21588 -22.1	21474 -24.6	-70
-75	17359 3.0	17928 2.4	18451 1.6	18922 [illegible]	19337 -.9	19692 -2.6	19987 -4.5	20220 -6.6	20394 -8.7	20511 -10.7	20574 -12.6	20590 -14.2	-75
-80	16690 9.4	16905 8.2	17296 7.0	17655 5.7	17984 4.4	18279 3.0	18540 1.7	18766 .4	18956 -.9	19113 -2.1	19237 -3.2	19331 -4.1	-80
-85	16131 13.4	16340 12.5	16541 11.7	16735 10.9	16919 10.1	17091 9.3	17252 8.6	17400 7.9	17535 7.3	17657 6.7	17764 6.2	17859 5.8	-85
-90	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	-90
LAT / E. LONG	240	245	250	255	260	265	270	275	280	285	290	295	LAT / E. LONG

HORIZONTAL COMPONENT (H) WMM-90

E. LONG / LAT	300	305	310	315	320	325	330	335	340	345	350	355	E. LONG / LAT
0	27574 -30.0	27568 -27.4	27614 -26.7	27651 -27.6	27629 -29.5	27528 -31.7	27362 -33.3	27177 -33.6	27037 -33.2	27004 -31.3	27119 -28.7	27380 -24.9	0
-5	26766 -37.4	26603 -36.9	26463 -38.0	26284 -40.4	26022 -43.7	25666 -47.2	25243 -49.9	24812 -51.4	24445 -51.2	24206 -49.5	24135 -46.7	24229 -43.5	-5
-10	25644 -43.2	25326 -44.5	25016 -47.5	24644 -51.2	24186 -56.0	23634 -60.8	23022 -64.8	22408 -67.3	21862 -68.1	21441 -67.2	21177 -64.8	21069 -61.6	-10
-15	24303 -48.2	23851 -51.0	23399 -55.1	22894 -60.3	22307 -66.3	21638 -72.3	20917 -77.5	20195 -81.2	19530 -83.2	18966 -83.3	18526 -81.6	18209 -78.6	-15
-20	22885 -53.6	22335 -57.2	21788 -62.0	21203 -68.1	20551 -74.9	19832 -81.8	19068 -87.9	18299 -92.7	17565 -95.6	16900 -96.5	16318 -95.4	15822 -92.5	-20
-25	21561 -59.6	20946 -63.5	20340 -68.5	19714 -74.8	19038 -82.0	18308 -89.3	17537 -96.0	16753 -101.2	15986 -104.6	15256 -105.7	14581 -104.5	13967 -100.7	-25
-30	20491 -66.0	19829 -69.7	19186 -74.5	18532 -80.5	17843 -87.4	17111 -94.5	16341 -101.0	15556 -106.0	14775 -109.0	14020 -109.8	13308 -107.5	12655 -103.5	-30
-35	19798 -71.5	19100 -74.9	18418 -79.1	17733 -84.4	17022 -90.5	16279 -96.7	15507 -102.2	14725 -106.1	13956 -107.9	13212 -107.2	12524 -103.6	11908 -97.0	-35
-40	19540 -74.5	18815 -77.7	18093 -81.3	17369 -85.5	16628 -90.3	15868 -94.9	15097 -98.7	14331 -100.8	13592 -100.7	12906 -98.1	12284 -92.8	11766 -84.8	-40
-45	19700 -73.9	18961 -76.9	18217 -79.6	17464 -83.0	16703 -86.1	15939 -88.6	15183 -90.1	14454 -89.9	13779 -87.7	13169 -83.2	12652 -76.4	12253 -67.6	-45
-50	20178 -69.1	19462 -72.0	18727 -74.4	17981 -76.3	17233 -77.7	16496 -78.1	15785 -77.3	15120 -74.9	14523 -70.7	14012 -64.8	13606 -57.2	13313 -48.4	-50
-55	20797 -60.7	20159 -63.5	19476 -65.2	18787 -65.1	18101 -66.0	17433 -64.7	16801 -62.2	16224 -58.2	15720 -52.8	15306 -46.3	14987 -38.8	14778 -30.8	-55
-60	21327 -50.0	20798 -52.3	20236 -53.6	19658 -53.8	19081 -52.7	18522 -50.5	18000 -47.1	17528 -42.5	17122 -37.0	16791 -30.7	16544 -24.1	16385 -17.4	-60
-65	21548 -38.2	21170 -40.1	20759 -40.9	20336 -40.7	19897 -39.4	19477 -37.1	19082 -33.8	18725 -29.6	18417 -24.8	18163 -19.6	17971 -14.3	17842 -9.1	-65
-70	21305 -26.5	21093 -27.8	20848 -28.4	20583 -28.1	20309 -27.0	20037 -25.2	19776 -22.7	19536 -19.8	19324 -16.1	19143 -12.3	18999 -8.6	18892 -4.9	-70
-75	20563 -15.4	20500 -16.2	20409 -16.6	20297 -16.4	20171 -15.8	20037 -14.7	19901 -13.2	19770 -11.5	19647 -9.2	19535 -7.0	19436 -4.7	19352 -2.4	-75
-80	19397 -4.8	19437 -5.3	19456 -5.5	19456 -5.6	19440 -5.3	19412 -4.9	19374 -4.2	19328 -3.4	19278 -2.4	19223 -1.3	19166 -.2	19107 1.0	-80
-85	17940 5.5	18008 5.2	18063 5.0	18107 4.9	18139 4.9	18161 5.0	18172 5.2	18174 5.4	18167 5.7	18151 6.1	18126 6.5	18093 7.0	-85
-90	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	16302 15.2	-90
LAT / E. LONG	300	305	310	315	320	325	330	335	340	345	350	355	LAT / E. LONG

TOTAL INTENSITY (F) WMM-90

E. LONG LAT	0	5	10	15	20	25	30	35	40	45	50	55	E. LONG LAT
90	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	90
85	55488 -13.9	55513 -13.9	55551 -14.1	55600 -14.3	55661 -14.5	55732 -14.9	55812 -15.3	55901 -15.8	55997 -16.3	56099 -16.8	56206 -17.4	56315 -18.1	85
80	54428 -4.4	54463 -4.4	54531 -4.5	54629 -4.7	54758 -5.2	54915 -5.8	55099 -6.5	55308 -7.3	55537 -8.3	55783 -9.4	56043 -10.6	56311 -11.9	80
75	53363 4.3	53393 4.6	53476 4.7	53612 4.4	53799 4.0	54035 3.2	54318 2.3	54645 1.2	55011 .0	55410 -1.4	55836 -2.9	56282 -4.4	75
70	52335 11.0	52354 11.7	52443 11.9	52603 11.7	52828 11.2	53122 10.4	53482 9.4	53902 8.2	54381 6.9	54912 5.6	55486 4.1	56095 2.6	70
65	51323 15.4	51337 16.3	51431 16.7	51605 16.5	51857 16.0	52186 15.1	52592 14.0	53072 12.8	53625 11.5	54247 10.5	54929 9.0	55662 7.8	65
60	50261 17.9	50287 19.1	50398 19.6	50591 19.5	50863 18.8	51212 17.8	51640 16.6	52147 15.2	52735 13.8	53402 12.6	54143 11.4	54949 10.5	60
55	49067 19.2	49127 20.8	49273 21.5	49498 21.5	49795 20.9	50162 19.7	50600 18.2	51114 16.4	51706 14.7	52380 13.1	53134 11.7	53962 10.6	55
50	47673 19.8	47789 22.0	47990 23.2	48262 23.5	48595 23.0	48986 21.7	49434 19.9	49945 17.6	50526 15.1	51183 12.7	51915 10.5	52722 8.7	50
45	46047 19.9	46233 22.8	46501 24.7	46832 25.6	47212 25.5	47632 24.2	48095 22.0	48605 19.0	49171 15.6	49798 12.0	50489 8.6	51243 5.8	45
40	44190 19.2	44449 22.9	44787 25.7	45179 27.4	45605 27.7	46057 26.6	46536 24.2	47048 20.5	47601 16.1	48198 11.3	48841 6.6	49528 2.5	40
35	42136 17.6	42463 22.1	42863 25.7	43304 28.0	43766 28.8	44240 27.8	44729 25.1	45243 21.0	45786 15.8	46358 10.1	46955 4.4	47575 -.7	35
30	39952 15.1	40335 20.0	40778 24.0	41250 26.6	41728 27.6	42207 26.6	42698 23.9	43203 19.5	43735 13.9	44285 7.9	44846 1.9	45408 -3.5	30
25	37751 12.4	38172 16.9	38640 20.5	39121 22.9	39595 23.6	40061 22.5	40530 19.6	41017 15.3	41527 10.0	42054 4.3	42584 -1.3	43106 -6.2	25
20	35687 9.9	36136 13.2	36613 15.7	37088 17.1	37544 17.1	37979 15.5	38408 12.5	38852 8.5	39321 3.8	39813 -.9	40317 -5.2	40818 -8.8	20
15	33939 8.2	34412 9.6	34895 10.2	35359 9.9	35788 8.6	36180 6.3	36551 3.1	36926 -.5	37329 -4.2	37769 -7.5	38246 -10.1	38747 -11.7	15
10	32635 7.5	33144 6.1	33642 4.5	34102 2.1	34505 -1.0	34846 -4.4	35142 -8.0	35427 -11.3	35740 -13.9	36116 -15.4	36570 -15.8	37098 -15.0	10
5	31787 7.0	32352 3.2	32885 -1.3	33355 -6.2	33738 -11.2	34025 -16.1	34236 -20.2	34419 -23.2	34638 -24.6	34955 -24.0	35408 -21.8	35999 -18.1	5
0	31266 5.6	31906 -.7	32491 -7.7	32981 -15.0	33347 -22.1	33580 -28.4	33708 -33.1	33799 -35.6	33946 -35.3	34239 -32.2	34736 -26.7	35643 -19.7	0
LAT E. LONG	0	5	10	15	20	25	30	35	40	45	50	55	LAT E. LONG

nT
(units: nT)

TOTAL INTENSITY (F) WMM-90

E. LONG / LAT	60	65	70	75	80	85	90	95	100	105	110	115	LAT / E. LONG
90	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	90
85	56426 -18.8	56536 -19.5	56644 -20.2	56748 -20.9	56848 -21.6	56941 -22.3	57026 -23.0	57103 -23.6	57170 -24.2	57227 -24.8	57275 -25.3	57311 -25.8	85
80	56583 -13.2	56854 -14.6	57116 -16.0	57371 -17.4	57607 -18.9	57822 -20.3	58011 -21.7	58172 -23.1	58302 -24.3	58399 -25.5	58463 -26.5	58494 -27.4	80
75	56738 -6.1	57194 -7.9	57642 -9.7	58070 -11.6	58467 -13.5	58824 -15.5	59132 -17.4	59383 -19.4	59572 -21.2	59694 -22.9	59748 -24.4	59735 -25.8	75
70	56725 1.0	57363 -.7	57994 -2.5	58599 -4.4	59163 -6.4	59667 -8.5	60097 -10.7	60438 -12.8	60679 -15.0	60813 -17.1	60836 -18.9	60750 -20.6	70
65	56431 6.6	57219 5.3	58006 4.0	58767 2.5	59479 .9	60117 -.9	60657 -2.9	61078 -4.9	61361 -7.1	61495 -9.2	61473 -11.1	61298 -12.9	65
60	55806 9.6	56696 8.9	57590 8.1	58464 7.3	59287 6.4	60025 5.3	60649 3.9	61128 2.4	61438 .8	61561 -1.0	61485 -2.7	61219 -4.2	60
55	54851 9.8	55781 9.3	56727 9.1	57659 8.9	58540 8.8	59334 8.5	60004 8.1	60513 7.5	60830 6.7	60930 5.8	60798 4.8	60430 3.8	55
50	53591 7.5	54507 6.9	55445 6.7	56375 7.0	57260 7.5	58061 8.2	58734 8.9	59241 9.5	59543 9.9	59612 10.2	59426 10.3	58978 10.2	50
45	52054 3.7	52909 2.4	53728 2.0	54665 2.3	55503 3.4	56263 4.9	56902 6.7	57377 8.6	57648 10.5	57680 12.1	57448 13.5	56940 14.5	45
40	50256 -.8	51019 -2.9	51605 -3.8	52590 -3.5	53344 -2.1	54029 .1	54602 2.9	55023 6.1	55250 9.3	55246 12.3	54981 14.9	54438 16.9	40
35	48215 -4.8	48875 -7.5	49551 -8.8	50226 -8.7	50877 -7.1	51467 -4.3	51959 -.7	52313 3.5	52491 7.8	52455 11.8	52172 15.3	51622 18.0	35
30	45971 -7.9	46538 -10.8	47112 -12.2	47684 -11.8	48232 -10.1	48728 -7.0	49136 -2.8	49423 1.9	49554 6.9	49493 11.5	49209 15.5	48676 18.4	30
25	43617 -10.0	44121 -12.4	44624 -13.4	45119 -12.8	45590 -10.7	46011 -7.4	46351 -3.0	46581 1.9	46674 7.0	46598 11.9	46326 15.6	45828 18.3	25
20	41312 -11.3	41798 -12.7	42279 -12.8	42747 -11.6	43186 -9.2	43570 -5.8	43873 -1.6	44069 3.1	44137 7.8	44054 12.0	43797 15.5	43346 17.8	20
15	39264 -12.4	39787 -12.2	40308 -11.0	40814 -9.1	41281 -6.3	41683 -3.0	41992 .8	42186 4.8	42246 8.8	42162 12.4	41921 15.1	41516 16.9	15
10	37683 -13.4	38303 -11.1	38934 -8.5	39547 -5.5	40110 -2.5	40591 .7	40956 3.9	41182 7.1	41256 10.1	41176 12.7	40948 14.7	40580 15.8	10
5	36704 -13.7	37482 -9.1	38287 -4.7	39074 -.7	39799 2.8	40418 5.8	40889 8.3	41184 10.5	41294 12.3	41228 13.8	41011 14.7	40671 15.0	5
0	36324 -12.1	37318 -4.8	38352 1.4	39369 6.2	40309 10.2	41115 12.8	41738 14.5	42141 15.5	42316 16.0	42283 16.0	42086 15.6	41773 14.7	0
LAT / E. LONG	60	65	70	75	80	85	90	95	100	105	110	115	LAT / E. LONG

TOTAL INTENSITY (F) WMM-90

E. LONG LAT	120	125	130	135	140	145	150	155	160	165	170	175	E. LONG LAT
90	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	90
85	57338 -26.2	57355 -26.5	57363 -26.8	57363 -27.0	57355 -27.1	57341 -27.2	57321 -27.2	57298 -27.2	57271 -27.1	57242 -26.9	57211 -26.8	57180 -26.5	85
80	58494 -28.2	58464 -28.8	58409 -29.2	58333 -29.4	58240 -29.5	58136 -29.4	58022 -29.1	57908 -28.7	57796 -28.2	57692 -27.6	57597 -26.9	57516 -26.3	80
75	59658 -26.8	59526 -27.6	59341 -28.1	59119 -28.2	58869 -28.1	58602 -27.6	58332 -26.8	58070 -25.9	57827 -24.7	57612 -23.4	57434 -22.1	57296 -20.8	75
70	60560 -21.9	60278 -22.9	59917 -23.4	59496 -23.4	59035 -23.0	58556 -22.1	58081 -20.9	57632 -19.2	57227 -17.4	56883 -15.4	56612 -13.4	56424 -11.5	70
65	60971 -14.3	60515 -15.4	59948 -15.9	59299 -15.9	58600 -15.3	57883 -14.1	57182 -12.5	56530 -10.5	55953 -8.2	55475 -5.7	55114 -3.2	54882 -.9	65
60	60745 -5.5	60110 -6.5	59335 -6.9	58457 -6.9	57519 -6.4	56567 -5.3	55646 -3.7	54797 -1.7	54058 .6	53456 3.1	53016 5.6	52744 7.9	60
55	59835 3.0	59036 2.3	58071 1.9	56985 1.9	55834 2.2	54675 2.9	53563 3.9	52548 5.2	51673 6.8	50969 8.6	50460 10.5	50160 12.3	55
50	58275 10.1	57343 9.8	56223 9.6	54972 9.3	53654 9.2	52335 9.0	51079 9.0	49941 9.0	48969 9.2	48194 9.6	47640 10.3	47319 11.1	50
45	56160 15.1	55135 15.4	53909 15.2	52546 14.7	51117 13.9	49696 12.7	48353 11.2	47147 9.5	46123 7.9	45316 6.4	44745 5.3	44420 4.9	45
40	53618 18.3	52546 18.9	51269 18.7	49854 17.9	48377 16.3	46918 13.9	45549 11.0	44328 7.6	43302 3.9	42502 .5	41946 -2.4	41640 -4.3	40
35	50800 19.8	49729 20.5	48457 20.2	47052 19.0	45592 16.7	44157 13.4	42819 9.3	41635 4.5	40651 -.6	39896 -5.7	39386 -10.2	39122 -13.4	35
30	47888 20.2	46863 20.8	45648 20.2	44310 18.6	42926 15.8	41573 12.1	40317 7.4	39216 2.0	38307 -4.0	37625 -9.9	37181 -15.3	36973 -19.5	30
25	45101 19.9	44159 20.1	43046 19.2	41823 17.3	40562 14.5	39334 10.8	38198 6.2	37206 .9	36397 -4.9	35799 -10.8	35475 -16.3	35269 -20.9	25
20	42697 18.9	41862 18.9	40880 17.8	39804 16.0	38696 13.4	37618 10.2	36620 6.3	35749 1.8	35038 -3.2	34516 -8.5	34195 -13.4	34064 -18.0	20
15	40947 17.6	40227 17.3	39387 16.4	38468 14.8	37522 12.9	36595 10.4	35731 7.5	34968 4.2	34336 .4	33861 -3.7	33553 -8.0	33403 -12.3	15
10	40083 16.1	39470 15.8	38764 15.1	37993 14.1	37193 12.8	36398 11.3	35644 9.5	34960 7.3	34371 4.6	33899 1.6	33553 -2.0	33329 -6.0	10
5	40232 14.8	39709 14.3	39116 13.7	38468 13.1	37785 12.5	37091 12.0	36412 11.2	35770 10.2	35185 8.6	34671 6.3	34240 3.3	33892 -.6	5
0	41381 13.6	40929 12.4	40423 11.5	39867 11.1	39270 11.1	38644 11.5	38007 11.9	37376 12.0	36761 11.4	36173 10.0	35624 7.3	35119 3.5	0
LAT E. LONG	120	125	130	135	140	145	150	155	160	165	170	175	LAT E. LONG

TOTAL INTENSITY (F) WMM-90

E. LONG / LAT	180	185	190	195	200	205	210	215	220	225	230	235	E. LONG / LAT
90	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	90
85	57149 -26.3	57118 -26.0	57088 -25.8	57058 -25.5	57029 -25.2	57000 -24.8	56971 -24.5	56942 -24.2	56911 -23.9	56879 -23.6	56844 -23.2	56806 -22.9	85
80	57649 -25.6	57399 -24.9	57364 -24.3	57345 -23.8	57339 -23.3	57346 -23.0	57357 -22.6	57376 -22.4	57396 -22.2	57414 -22.1	57426 -21.9	57429 -21.8	80
75	57204 -19.6	57158 -18.6	57158 -17.8	57198 -17.2	57276 -16.9	57384 -16.9	57515 -17.1	57660 -17.5	57810 -18.0	57957 -18.7	58093 -19.4	58209 -20.1	75
70	56322 -9.9	56308 -8.6	56377 -7.8	56524 -7.5	56738 -7.7	57006 -8.4	57314 -9.7	57648 -11.3	57991 -13.2	58328 -15.3	58644 -17.4	58927 -19.4	70
65	54783 1.0	54818 2.3	54980 3.0	55259 2.8	55637 1.8	56096 .0	56616 -2.6	57169 -5.8	57737 -9.5	58296 -13.3	58825 -17.1	59306 -20.7	65
60	52854 9.7	52740 11.0	52994 11.4	53402 10.8	53942 9.1	54589 6.3	55313 2.4	56086 -2.4	56877 -7.8	57658 -13.5	58403 -19.0	59089 -24.1	60
55	50074 13.9	50200 15.0	50527 15.3	51038 14.6	51709 12.6	52508 9.2	53404 4.5	54359 -1.5	55339 -8.3	56312 -15.5	57247 -22.6	58119 -29.1	55
50	47236 12.2	47385 13.1	47756 13.6	48330 13.3	49082 11.7	49980 8.6	50987 3.8	52065 -2.6	53176 -10.3	54286 -18.6	55364 -26.9	56383 -34.6	50
45	44342 5.1	44506 5.9	44892 6.9	45488 7.5	46267 7.0	47200 5.0	48250 1.0	49380 -5.0	50552 -12.8	51733 -21.7	52892 -30.8	54006 -39.2	45
40	41579 -5.0	41750 -4.4	42137 -2.9	42721 -1.1	43479 .0	44386 -.4	45412 -3.0	46524 -8.0	47687 -15.2	48872 -24.0	50049 -33.4	51197 -42.4	40
35	39091 -14.9	39275 -14.7	39649 -12.9	40194 -10.3	40891 -7.8	41722 -6.5	42667 -7.5	43701 -11.1	44796 -17.3	45924 -25.5	47060 -34.7	48184 -43.6	35
30	36980 -21.9	37173 -22.2	37523 -20.7	38006 -17.9	38609 -14.8	39326 -12.5	40147 -12.2	41057 -14.5	42037 -19.5	43061 -26.7	44105 -35.0	45151 -43.3	30
25	35306 -24.0	35492 -25.3	35797 -24.8	36195 -22.8	36680 -20.2	37253 -17.9	37920 -17.1	38675 -18.5	39506 -22.3	40385 -28.2	41295 -35.2	42216 -42.2	25
20	34096 -21.6	34247 -24.1	34479 -25.1	34767 -24.8	35112 -23.7	35524 -22.5	36017 -22.1	36595 -23.2	37247 -26.0	37953 -30.4	38693 -35.6	39649 -40.9	20
15	33383 -16.3	33453 -19.9	33576 -22.7	33730 -24.6	33918 -25.6	34158 -26.2	34466 -26.8	34851 -28.1	35305 -30.3	35812 -33.3	36353 -36.7	36915 -39.9	15
10	33205 -10.3	33146 -14.9	33123 -19.4	33120 -23.5	33140 -26.4	33200 -28.8	33317 -30.7	33498 -32.5	33741 -34.3	34030 -36.2	34354 -38.0	34703 -39.5	10
5	33614 -5.3	33386 -10.7	33188 -16.3	33009 -21.8	32852 -26.5	32728 -30.3	32650 -33.3	32624 -35.6	32646 -37.4	32709 -38.7	32807 -39.5	32935 -39.7	5
0	34658 -1.6	34237 -7.7	33846 -14.3	33480 -20.7	33139 -26.5	32829 -31.2	32555 -34.9	32319 -37.5	32122 -39.4	31959 -40.4	31830 -40.8	31740 -40.4	0
LAT / E. LONG	180	185	190	195	200	205	210	215	220	225	230	235	LAT / E. LONG

TOTAL INTENSITY (F) WMM-90

E. LONG / LAT	240	245	250	255	260	265	270	275	280	285	290	295	E. LONG / LAT
90	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	90
85	56765 -22.5	56720 -22.2	56670 -21.8	56616 -21.4	56557 -21.0	56494 -20.6	56427 -20.2	56356 -19.7	56281 -19.3	56204 -18.8	56126 -18.3	56047 -17.8	85
80	57420 -21.7	57396 -21.5	57355 -21.3	57294 -21.0	57214 -20.6	57114 -20.1	56993 -19.6	56853 -18.9	56696 -18.2	56524 -17.4	56338 -16.5	56144 -15.5	80
75	58297 -20.8	58352 -21.3	58369 -21.6	58344 -21.8	58274 -21.8	58157 -21.6	57995 -21.2	57789 -20.6	57543 -19.8	57260 -18.7	56946 -17.5	56608 -16.1	75
70	59163 -21.2	59343 -22.7	59458 -24.0	59502 -24.8	59469 -25.3	59357 -25.4	59167 -25.3	58901 -24.8	58564 -24.0	58164 -23.0	57709 -21.6	57213 -19.9	70
65	59721 -23.8	60057 -26.4	60301 -28.4	60442 -29.9	60473 -30.7	60390 -31.1	60190 -31.2	59878 -30.9	59459 -30.3	58945 -29.3	58350 -28.0	57692 -26.5	65
60	59694 -28.5	60202 -32.1	60594 -34.7	60858 -36.4	60980 -37.4	60951 -37.9	60769 -38.0	60433 -37.8	59952 -37.4	59340 -36.8	58617 -35.8	57808 -34.5	60
55	58905 -34.6	59564 -38.8	60176 -41.8	60536 -43.6	60772 -44.5	60826 -44.8	60689 -44.9	60359 -44.8	59844 -44.8	59159 -44.7	58332 -44.2	57395 -43.1	55
50	57321 -40.9	58153 -45.7	58854 -48.8	59399 -50.5	59761 -51.1	59918 -51.2	59853 -51.2	59558 -51.4	59039 -51.9	58314 -52.4	57414 -52.7	56379 -52.2	50
45	55050 -46.3	56001 -51.4	56879 -54.6	57502 -56.2	57987 -56.6	58253 -56.6	58273 -56.7	58035 -57.3	57541 -58.5	56807 -60.0	55868 -61.1	54770 -61.3	45
40	52294 -49.8	53315 -55.3	54229 -58.5	54998 -60.0	55583 -60.4	55943 -60.5	56048 -61.0	55876 -62.4	55426 -64.6	54711 -67.2	53765 -69.3	52639 -70.3	40
35	49276 -51.2	50310 -56.7	51256 -60.0	52074 -61.5	52719 -62.1	53146 -62.6	53317 -63.8	53208 -66.3	52811 -69.8	52135 -73.7	51211 -77.1	50092 -78.9	35
30	46181 -50.4	47171 -55.5	48092 -58.8	48904 -60.4	49561 -61.2	50016 -62.4	50229 -64.7	50170 -68.5	49827 -73.5	49203 -78.9	48326 -83.6	47245 -86.4	30
25	43132 -49.2	44025 -52.6	44868 -55.3	45626 -58.2	46249 -57.9	46696 -59.8	46924 -63.3	46900 -68.5	46606 -75.1	46042 -82.1	45231 -88.2	44217 -92.0	25
20	40211 -45.3	40963 -48.4	41685 -50.2	42345 -51.3	42903 -52.6	43313 -55.1	43533 -59.5	43527 -66.0	43276 -74.0	42776 -82.4	42043 -89.8	41117 -94.6	20
15	37491 -42.4	38072 -43.9	38644 -44.6	39180 -45.9	39645 -46.2	39996 -48.9	40186 -53.9	40184 -61.2	39966 -70.2	39524 -79.6	38873 -87.9	38048 -93.5	15
10	35075 -40.2	35469 -40.2	35871 -39.7	36267 -39.4	36613 -40.0	36880 -42.5	37021 -47.5	37002 -55.6	36797 -64.2	36401 -74.0	35825 -82.6	35100 -88.6	10
5	33097 -39.2	33292 -38.1	33515 -36.7	33747 -35.5	33960 -35.5	34116 -37.3	34176 -41.6	34108 -48.4	33888 -57.1	33513 -66.3	32993 -74.6	32358 -80.2	5
0	31692 -39.4	31689 -37.8	31723 -35.8	31779 -34.1	31830 -33.3	31841 -34.1	31781 -37.3	31622 -42.8	31348 -50.1	30957 -58.0	30464 -65.0	29898 -69.7	0
LAT / E. LONG	240	245	250	255	260	265	270	275	280	285	290	295	LAT / E. LONG

TOTAL INTENSITY (F) WMM-90

E. LONG / LAT	300	305	310	315	320	325	330	335	340	345	350	355	E. LONG / LAT
90	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	56443 -21.9	90
85	55968 -17.3	55892 -16.9	55818 -16.4	55748 -16.0	55684 -15.5	55626 -15.1	55576 -14.8	55535 -14.5	55503 -14.3	55482 -14.1	55472 -13.6	55474 -13.9	85
80	55943 -14.5	55740 -13.4	55540 -12.3	55345 -11.2	55159 -10.1	54988 -9.0	54836 -8.0	54700 -7.1	54590 -6.3	54506 -5.6	54450 -5.0	54423 -4.6	80
75	56254 -14.5	55891 -12.8	55527 -11.0	55171 -9.1	54830 -7.1	54512 -5.1	54222 -3.2	53967 -1.4	53753 .2	53582 1.6	53459 2.8	53385 3.7	75
70	56687 -17.9	56146 -15.7	55602 -13.1	55069 -10.7	54560 -7.4	54066 -4.3	53655 -1.3	53277 1.5	52957 4.2	52699 6.5	52509 8.5	52387 10.0	70
65	56992 -24.1	56269 -21.4	55546 -18.2	54841 -14.6	54172 -10.6	53554 -6.4	52999 -2.2	52515 1.9	52109 5.6	51786 9.0	51547 11.7	51393 13.9	65
60	56944 -32.2	56053 -29.2	55165 -25.5	54308 -21.0	53503 -16.0	52769 -10.6	52119 -5.1	51562 .3	51103 5.2	50745 9.6	50486 13.2	50326 16.0	60
55	56389 -41.2	55353 -38.1	54328 -33.9	53348 -28.6	52441 -22.4	51628 -15.8	50921 -9.0	50328 -2.4	49850 3.7	49488 9.0	49240 13.4	49102 16.8	55
50	55261 -50.5	54111 -47.4	52980 -42.6	51913 -36.4	50941 -29.1	50087 -21.2	49361 -13.2	48766 -5.5	48301 1.5	47964 7.6	47751 12.7	47657 16.8	50
45	53576 -59.0	52344 -56.6	51141 -51.3	50019 -44.2	49017 -35.7	48156 -26.6	47444 -17.4	46877 -8.8	46450 -1.1	46158 5.7	45998 11.4	45964 16.1	45
40	51401 -69.3	50124 -65.8	48881 -59.8	47736 -51.7	46732 -42.1	45891 -31.8	45216 -21.8	44699 -12.4	44329 -4.1	44097 3.1	44000 9.3	44034 14.6	40
35	48847 -78.2	47557 -74.6	46306 -67.9	45163 -58.9	44179 -48.2	43376 -37.0	42755 -26.2	42301 -16.3	41997 -7.6	41834 -.1	41806 6.5	41910 12.3	35
30	46029 -86.2	44763 -82.5	43533 -75.4	42417 -65.5	41470 -53.9	40717 -41.8	40156 -30.2	39771 -19.9	39540 -10.9	39449 -3.1	39492 3.6	39664 9.6	30
25	43064 -92.4	41856 -88.8	40679 -81.3	39615 -70.8	38721 -58.3	38028 -45.4	37535 -33.1	37224 -22.2	37071 -12.9	37058 -5.2	37175 1.4	37409 7.2	25
20	40057 -95.7	38939 -92.3	37848 -84.7	36861 -73.6	36043 -60.4	35425 -46.5	35015 -33.4	34792 -22.0	34731 -12.6	34807 -5.1	35001 .9	35300 5.8	20
15	37100 -95.1	36099 -92.0	35121 -84.3	34244 -72.8	33530 -58.8	33019 -44.0	32719 -30.2	32613 -18.3	32667 -9.0	32850 -2.1	33136 2.7	33506 6.8	15
10	34274 -90.4	33406 -87.4	32568 -79.5	31831 -67.5	31260 -52.8	30894 -37.4	30743 -23.0	30786 -11.1	30984 -2.3	31296 3.4	31691 6.5	32144 7.6	10
5	31650 -81.8	30925 -78.6	30246 -70.5	29680 -58.1	29285 -43.1	29100 -27.4	29126 -13.2	29342 -1.9	29698 5.8	30150 9.9	30665 10.9	31217 9.7	5
0	29299 -70.5	28717 -66.7	28406 -58.3	27830 -45.6	27632 -31.2	27640 -16.2	27850 -3.0	28229 6.9	28732 12.9	29315 15.1	29947 14.1	30604 10.7	0
LAT / E. LONG	300	305	310	315	320	325	330	335	340	345	350	355	LAT / E. LONG

TOTAL INTENSITY (F) WMM-90

E. LONG / LAT	0	5	10	15	20	25	30	35	40	45	50	55	LAT
0	31266 5.6	31906 -.7	32491 -7.7	32981 -15.0	33347 -22.1	33580 -28.4	33706 -33.1	33799 -35.6	33946 -35.3	34239 -32.2	34776 -26.7	35643 -19.7	0
-5	30871 1.9	31582 -6.4	32216 -15.6	32720 -24.9	33065 -33.7	33246 -41.0	33304 -45.6	33336 -47.1	33462 -44.5	33795 -38.1	34405 -28.8	35295 -17.9	-5
-10	30418 -5.4	31164 -15.1	31809 -25.5	32301 -36.0	32607 -45.6	32737 -52.9	32756 -56.7	32782 -55.9	32960 -50.0	33419 -39.5	34224 -26.0	35362 -11.3	-10
-15	29808 -17.2	30522 -27.3	31122 -38.0	31556 -48.4	31802 -57.2	31889 -63.0	31905 -64.2	31991 -59.9	32307 -49.7	32979 -34.8	34055 -17.2	35498 .4	-15
-20	29032 -33.6	29643 -43.2	30136 -52.8	30469 -61.5	30642 -67.7	30705 -70.1	30768 -67.1	30989 -57.9	31524 -42.8	32481 -23.8	33879 -3.3	35652 15.6	-20
-25	28156 -54.1	28609 -62.3	28956 -69.5	29176 -74.6	29290 -76.5	29370 -75.7	29543 -65.0	29966 -50.3	30779 -30.6	32057 -8.6	33785 12.9	35871 31.1	-25
-30	27292 -76.9	27579 -82.8	27788 -86.5	27924 -87.0	28027 -83.2	28187 -74.1	28535 -59.3	29210 -39.5	30322 -16.5	31906 6.6	33919 27.1	36256 42.7	-30
-35	26593 -98.6	26753 -101.9	26881 -101.6	27001 -97.0	27170 -87.4	27481 -72.4	28052 -52.6	28992 -29.4	30372 -5.3	32197 16.8	34405 34.7	36896 46.8	-35
-40	26255 -115.4	26361 -116.1	26489 -112.2	26676 -103.2	26983 -89.1	27493 -70.2	28295 -47.9	29466 -24.0	31040 -1.2	33005 18.4	35300 32.8	37836 41.3	-40
-45	26507 -123.8	26629 -122.4	26826 -116.1	27136 -104.7	27613 -88.7	28318 -69.0	29312 -47.3	30639 -25.4	32312 -5.6	34311 10.4	36585 21.4	39066 27.0	-45
-50	27557 -122.6	27734 -120.1	28023 -113.1	28459 -101.8	29080 -86.9	29926 -69.4	31033 -50.9	32422 -33.0	34096 -17.3	36036 -5.0	38204 3.1	40549 6.7	-50
-55	29511 -114.1	29739 -111.4	30099 -105.4	30615 -98.2	31313 -84.5	32216 -71.2	33343 -57.3	34703 -44.1	36294 -32.7	38100 -23.9	40095 -18.2	42243 -15.6	-55
-60	32325 -102.6	32576 -100.6	32960 -96.4	33494 -90.2	34193 -82.3	35070 -73.5	36135 -64.4	37389 -55.7	38830 -48.2	40445 -42.3	42216 -38.3	44118 -36.1	-60
-65	35835 -92.4	36078 -91.1	36444 -88.7	36942 -85.1	37583 -80.6	38372 -75.6	39313 -70.4	40407 -65.[illegible]	41649 -60.8	43030 -57.1	44536 -54.3	46150 -52.4	-65
-70	39826 -85.6	40040 -85.0	40359 -83.7	40789 -82.0	41333 -79.8	41996 -77.3	42777 -74.6	43675 -72.0	44686 -69.5	45803 -67.2	47016 -65.3	48313 -63.6	-70
-75	44082 -82.7	44257 -82.2	44514 -81.6	44856 -80.7	45284 -79.7	45799 -78.5	46399 -77.3	47083 -75.9	47846 -74.6	48683 -73.2	49587 -71.9	50549 -70.6	-75
-80	48408 -82.2	48537 -81.8	48721 -81.4	48963 -80.9	49261 -80.3	49614 -79.7	50022 -79.0	50481 -78.[illegible]	50988 -77.5	51541 -76.7	52133 -75.8	52760 -75.0	-80
-85	52615 -82.2	52686 -81.9	52786 -81.6	52914 -81.3	53069 -80.9	53251 -80.6	53457 -80.2	53686 -79.8	53938 -79.4	54209 -79.0	54498 -78.6	54802 -78.2	-85
-90	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	-90
LAT / E. LONG	0	5	10	15	20	25	30	35	40	45	50	55	LAT

TOTAL INTENSITY (F) WMM-90

E. LONG / LAT	60	65	70	75	80	85	90	95	100	105	110	115	E. LONG / LAT
0	36324 -12.1	37316 -4.9	38352 1.4	39369 6.5	40309 10.2	41115 12.8	41738 14.5	42141 15.5	42316 16.0	42283 16.0	42086 15.6	41773 14.7	0
-5	36408 -7.0	37662 2.8	38971 10.6	40256 16.7	41449 19.9	42483 21.8	43296 22.3	43847 21.9	44124 20.9	44158 19.2	44005 17.1	43729 14.7	-5
-10	36758 2.5	38310 14.1	39916 22.6	41491 28.1	42958 33.8	44245 31.3	45281 30.3	46018 28.2	46442 25.4	46584 22.1	46509 18.3	46294 14.2	-10
-15	37209 15.8	39072 27.8	40981 35.7	42846 39.7	44591 40.5	46140 39.0	47419 36.0	48373 32.2	48984 27.9	49279 23.1	49324 18.0	49200 12.5	-15
-20	37683 30.9	39847 41.4	42039 47.1	44174 48.5	46180 46.6	47981 42.6	49505 37.5	50691 32.1	51516 26.8	52000 21.1	52203 15.5	52203 9.6	-20
-25	38189 44.3	40616 51.9	43047 54.1	45611 52.1	47640 47.0	49664 40.4	51413 33.5	52827 27.1	53877 21.3	54571 16.1	54959 11.0	55109 5.8	-25
-30	38791 52.5	41410 56.1	44020 54.5	46555 49.0	48954 41.1	51155 32.6	53096 24.6	54712 18.0	55975 12.8	56883 8.8	57469 5.4	57789 2.0	-30
-35	39555 52.6	42281 52.5	44993 47.6	47630 39.4	50138 29.8	52462 20.3	54544 12.3	56328 6.5	57778 2.8	58885 .9	59666 -.1	60162 -.9	-35
-40	40518 43.8	43260 41.0	45994 34.1	48663 24.8	51217 14.9	53606 5.9	55776 -.8	57679 -5.1	59277 -6.7	60553 -6.2	61510 -4.5	62173 -2.7	-40
-45	41679 27.4	44355 23.3	47034 16.2	49665 7.5	52201 -1.2	54595 -8.4	56798 -13.2	58766 -15.2	60462 -14.5	61863 -11.8	62963 -7.8	63771 -3.8	-45
-50	43017 6.3	45554 2.5	48108 -3.4	50633 -10.1	53085 -16.3	55421 -21.0	57595 -23.4	59567 -23.2	61302 -20.5	62775 -16.1	63972 -10.7	64892 -5.4	-50
-55	44505 -15.8	46839 -18.2	49202 -21.9	51554 -26.0	53855 -29.3	56063 -31.3	58140 -31.4	60049 -29.4	61757 -25.5	63239 -20.4	64478 -14.5	65466 -8.9	-55
-60	46121 -35.7	48195 -36.4	50305 -37.8	52417 -39.2	54496 -40.0	56506 -39.7	58414 -38.1	60187 -35.1	61797 -30.9	63221 -25.8	64441 -20.5	65447 -15.4	-60
-65	47852 -51.3	49616 -50.6	51416 -50.2	53226 -49.7	55017 -48.7	56761 -47.1	58429 -44.6	59996 -41.5	61439 -37.6	62738 -33.4	63876 -29.2	64844 -25.3	-65
-70	49678 -62.2	51093 -60.8	52561 -59.5	54001 -58.1	55652 -56.5	56872 -54.3	58243 -51.9	59543 -49.2	60757 -46.3	61868 -43.3	62864 -40.4	63736 -37.8	-70
-75	51559 -69.3	52606 -67.9	53677 -66.5	54760 -65.0	55839 -63.4	56902 -61.7	57936 -59.9	58927 -58.1	59863 -56.2	60736 -54.4	61536 -52.7	62252 -51.3	-75
-80	53416 -74.0	54095 -73.1	54788 -72.1	55490 -71.1	56192 -70.1	56887 -69.1	57567 -68.1	58226 -67.1	58856 -66.1	59452 -65.3	60008 -64.5	60520 -63.9	-80
-85	55118 -77.7	55445 -77.3	55779 -76.9	56116 -76.5	56455 -76.0	56791 -75.7	57123 -75.3	57447 -74.9	57759 -74.6	58059 -74.4	58343 -74.1	58609 -74.0	-85
-90	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	-90
LAT / E. LONG	60	65	70	75	80	85	90	95	100	105	110	115	LAT / E. LONG

TOTAL INTENSITY (F) WMM-90

E. LONG LAT	120	125	130	135	140	145	150	155	160	165	170	175	E. LONG LAT
0	41381 13.6	40929 12.4	40423 11.5	39867 11.1	39270 11.1	38644 11.5	38007 11.9	37376 12.0	36761 11.4	36173 10.0	35624 7.3	35119 3.5	0
-5	43381 12.1	42985 9.8	42546 8.1	42958 7.4	41520 7.7	40937 8.9	40319 10.5	39675 12.0	39011 12.8	38334 12.3	37655 10.1	36986 6.2	-5
-10	45999 10.0	45656 6.2	45271 3.4	44834 2.0	44338 2.3	43780 4.1	43165 6.8	42497 9.8	41777 12.0	41012 12.6	40211 11.1	39391 7.4	-10
-15	48976 7.0	48690 1.9	48354 -2.0	47958 -4.2	47492 -4.3	46950 -2.4	46329 1.1	45631 5.1	44858 8.5	44016 10.2	43114 9.6	42172 6.2	-15
-20	52071 3.5	51853 -2.2	51567 -6.9	51207 -9.9	50764 -10.7	50228 -9.2	49596 -5.8	48869 -1.6	48050 2.3	47146 4.6	46170 4.5	45139 1.6	-20
-25	55092 .3	54955 -5.1	54723 -9.9	54397 -13.5	53971 -15.2	53436 -14.7	52791 -12.4	52038 -9.1	51183 -5.9	50237 -3.8	49212 -3.8	48127 -6.4	-25
-30	57904 -1.8	57862 -6.0	57690 -10.3	57398 -14.0	56986 -16.6	56450 -17.6	55793 -17.3	55021 -15.9	54143 -14.4	53172 -13.6	52124 -14.2	51018 -16.5	-30
-35	60420 -2.4	60482 -4.7	60379 -7.6	60126 -11.3	59731 -14.6	59199 -17.4	58536 -19.4	57756 -20.6	56867 -21.6	55891 -22.7	54844 -24.4	53743 -26.7	-35
-40	62575 -1.6	62750 -1.9	62726 -3.5	62523 -5.5	62157 -10.3	61639 -14.5	60985 -18.7	60209 -22.5	59332 -26.1	58372 -29.3	57348 -32.2	56278 -34.9	-40
-45	64308 -.6	64597 .9	64663 .6	64528 -1.7	64211 -5.6	63732 -10.6	63110 -16.3	62367 -22.1	61525 -27.7	60607 -32.6	59632 -36.7	58620 -39.7	-45
-50	65544 -1.0	65944 1.8	66109 2.4	66061 .8	65822 -2.8	65614 -8.0	64861 -14.2	64187 -20.9	63416 -27.5	62573 -33.4	61678 -38.2	60750 -41.4	-50
-55	66205 -4.2	66702 -1.1	66971 .1	67030 -.9	66898 -3.9	66599 -8.6	66156 -14.5	65593 -21.0	64936 -27.6	64206 -33.5	63425 -38.4	62610 -41.7	-55
-60	66236 -11.2	66809 -8.4	67176 -7.2	67350 -7.7	67347 -10.0	67186 -13.8	66888 -18.7	66475 -24.2	65969 -29.8	65389 -35.0	64754 -39.4	64078 -42.6	-60
-65	65636 -22.1	66252 -19.6	66696 -19.0	66975 -19.3	67101 -20.8	67087 -23.5	66951 -27.1	66707 -31.1	66373 -35.4	65964 -39.5	65496 -43.0	64976 -45.8	-65
-70	64478 -35.7	65088 -34.3	65566 -33.7	65916 -33.9	66144 -34.8	66258 -36.5	66267 -38.8	66183 -41.4	66015 -44.3	65773 -47.1	65466 -49.7	65103 -52.0	-70
-75	62884 -50.2	63427 -49.5	63880 -49.2	64243 -49.3	64517 -49.8	64707 -50.7	64815 -52.0	64848 -53.5	64809 -55.2	64706 -56.9	64538 -58.6	64315 -60.3	-75
-80	60983 -63.4	61395 -63.2	61753 -63.1	62057 -63.1	62305 -63.4	62498 -63.9	62636 -64.5	62721 -65.2	62754 -66.1	62736 -67.0	62670 -67.9	62557 -68.9	-80
-85	58854 -73.9	59078 -73.9	59278 -73.8	59454 -73.9	59604 -74.0	59727 -74.1	59824 -74.4	59893 -74.7	59935 -75.0	59949 -75.4	59936 -75.8	59897 -76.2	-85
-90	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	-90
LAT E. LONG	120	125	130	135	140	145	150	155	160	165	170	175	LAT E. LONG

TOTAL INTENSITY (F) WMM-90

E. LONG / LAT	180	185	190	195	200	205	210	215	220	225	230	235	E. LONG / LAT
0	34558 -1.8	34237 -7.7	33849 -14.3	33480 -20.7	33139 -26.5	32829 -31.2	32555 -34.9	32319 -37.5	32122 -39.4	31959 -40.4	31830 -40.8	31740 -40.4	0
-5	36338 .7	35719 -6.1	35131 -13.4	34576 -20.6	34051 -26.9	33556 -32.1	33090 -36.1	32652 -38.9	32242 -40.7	31862 -41.8	31517 -41.6	31215 -41.4	-5
-10	39572 1.6	37771 -5.8	37001 -13.8	36265 -21.5	35564 -28.3	34896 -33.7	34249 -37.6	33625 -40.1	33021 -41.6	32444 -42.2	31900 -42.2	31401 -41.7	-10
-15	41213 .3	40260 -7.3	39333 -15.7	38440 -23.7	37583 -30.6	36758 -35.7	35957 -39.1	35175 -41.0	34409 -41.6	33664 -41.5	32948 -40.9	32271 -40.2	-15
-20	44079 -3.9	43014 -11.3	41966 -19.3	40949 -26.9	39967 -33.2	39019 -37.5	38098 -39.8	37196 -40.3	36308 -39.6	35436 -38.3	34578 -36.9	33746 -35.8	-20
-25	47006 -11.2	45871 -17.5	44745 -24.3	43645 -30.5	42579 -35.1	41549 -37.7	40549 -38.0	39570 -36.7	38602 -34.3	37638 -31.6	36676 -29.4	35715 -28.0	-25
-30	49872 -20.3	48709 -25.1	47550 -29.8	46413 -33.6	45308 -35.6	44239 -35.5	43202 -33.4	42185 -29.9	41174 -25.7	40155 -21.8	39116 -19.0	38050 -17.9	-30
-35	52607 -29.6	51454 -32.4	50304 -34.6	49173 -35.3	48072 -34.2	47005 -31.1	45967 -26.4	44946 -20.8	43917 -15.3	42865 -10.6	41771 -7.9	40619 -7.5	-35
-40	55181 -36.9	54071 -38.0	52965 -37.6	51877 -35.5	50815 -31.6	49781 -25.9	48767 -19.2	47757 -12.2	46729 -5.9	45658 -1.2	44522 1.0	43304 .2	-40
-45	57586 -41.2	56545 -41.1	55510 -39.0	54490 -34.9	53489 -29.1	52506 -22.0	51529 -14.3	50541 -6.9	49519 -.7	48437 3.3	47273 4.4	46009 2.3	-45
-50	59804 -42.8	58853 -42.2	57906 -39.4	56968 -34.7	56039 -28.5	55113 -21.4	54178 -14.0	53215 -7.3	52202 -2.2	51118 .6	49941 .6	48658 -2.5	-50
-55	61775 -43.2	60931 -42.7	60083 -40.4	59233 -36.4	58378 -31.1	57511 -25.2	56618 -19.4	55683 -14.4	54689 -10.9	53616 -9.4	52451 -10.5	51183 -14.1	-55
-60	63374 -44.3	62649 -44.5	61908 -43.2	61150 -40.7	60372 -37.3	59566 -33.5	58722 -29.8	57826 -26.9	56867 -25.1	55832 -24.9	54711 -26.6	53501 -30.2	-60
-65	64413 -47.7	63819 -48.6	63191 -48.5	62533 -47.7	61840 -46.3	61108 -44.6	60329 -43.1	59496 -42.1	58601 -41.9	57639 -42.6	56604 -44.6	55496 -47.7	-65
-70	64689 -53.8	64229 -55.1	63725 -55.9	63178 -56.4	62587 -56.5	61951 -56.5	61266 -56.6	60529 -57.0	59737 -57.7	58890 -59.0	57986 -60.7	57027 -63.1	-70
-75	64039 -61.8	63712 -63.1	63338 -64.2	62917 -65.3	62451 -66.2	61939 -67.1	61383 -67.9	60782 -68.9	60137 -70.0	59449 -71.2	58720 -72.6	57953 -74.2	-75
-80	62400 -69.9	62199 -70.9	61956 -71.9	61674 -72.9	61353 -73.8	60995 -74.7	60602 -75.6	60175 -76.5	59716 -77.5	59228 -78.4	58713 -79.3	58174 -80.3	-80
-85	59831 -76.6	59740 -77.1	59675 -77.6	59486 -78.1	59324 -78.6	59140 -79.1	58937 -79.6	58714 -80.1	58475 -80.6	58219 -81.0	57949 -81.5	57668 -81.9	-85
-90	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	-90
LAT / E. LONG	180	185	190	195	200	205	210	215	220	225	230	235	LAT / E. LONG

TOTAL INTENSITY (F) WMM-90

E. LONG / LAT	240	245	250	255	260	265	270	275	280	285	290	295	E. LONG / LAT
0	31692 -19.4	31689 -37.8	31724 -35.8	31779 -34.1	31830 -33.3	31841 -34.1	31781 -37.3	31622 -42.8	31346 -50.1	30957 -58.0	30664 -65.0	29898 -69.7	0
-5	30864 -40.3	30762 -38.6	30604 -36.6	30469 -34.7	30332 -33.3	30165 -33.3	29942 -35.1	29646 -39.0	29270 -44.3	28821 -50.3	28318 -55.5	27794 -58.5	-5
-10	30953 -40.7	30557 -39.4	30200 -37.8	29963 -36.0	29520 -34.7	29146 -34.1	28726 -34.9	28248 -37.1	27724 -40.5	27173 -44.3	26621 -47.4	26106 -48.5	-10
-15	31638 -39.4	31049 -38.5	30490 -37.6	29941 -36.7	29378 -35.9	28778 -35.6	28133 -36.0	27448 -37.2	26744 -39.0	26054 -40.8	25417 -41.8	24876 -41.1	-15
-20	32942 -35.1	32164 -35.0	31400 -35.2	30631 -35.7	29837 -36.3	29003 -37.1	28126 -38.0	27226 -39.0	26320 -39.9	25469 -40.3	24729 -39.7	24121 -37.5	-20
-25	34756 -27.9	33795 -29.9	32824 -30.8	31831 -33.3	30803 -36.0	29733 -38.6	28627 -40.9	27506 -42.9	26412 -43.4	25398 -43.1	24524 -41.3	23843 -38.0	-25
-30	36952 -18.7	35820 -21.3	34650 -25.4	33638 -30.4	32184 -35.7	30890 -40.8	29570 -45.0	28253 -47.9	26984 -49.3	25820 -48.9	24822 -46.7	24046 -42.7	-30
-35	39403 -9.7	38119 -14.3	36772 -20.8	35365 -28.5	33909 -36.6	32419 -44.1	30916 -50.4	29435 -54.9	28023 -57.2	26734 -57.1	25628 -54.8	24755 -50.6	-35
-40	41994 -3.7	40592 -10.2	39105 -19.0	37546 -29.0	35935 -39.3	34295 -48.9	32657 -56.9	31058 -62.8	29545 -65.9	28167 -66.3	26976 -64.2	26015 -60.2	-40
-45	44637 -2.9	43159 -11.0	41585 -21.1	39936 -32.5	38232 -44.1	36508 -54.8	34797 -63.8	33138 -70.3	31574 -74.0	30149 -74.9	28903 -73.2	27872 -69.6	-45
-50	47263 -8.6	45760 -17.7	44163 -27.7	42491 -39.2	40772 -50.7	39039 -61.3	37326 -70.1	35671 -76.6	34111 -80.4	32684 -81.5	31420 -80.2	30344 -77.3	-50
-55	49811 -20.2	48340 -28.3	46784 -37.9	45164 -48.7	43505 -58.4	41837 -67.7	40192 -75.4	38604 -81.1	37106 -84.5	35720 -85.6	34477 -84.8	33391 -82.5	-55
-60	52201 -35.6	50812 -42.4	49367 -50.1	47864 -58.3	46332 -66.3	44797 -73.5	43283 -79.5	41819 -83.9	40429 -86.5	39134 -87.5	37952 -86.9	36895 -85.3	-60
-65	54318 -51.8	53078 -58.8	51785 -62.3	50456 -68.0	49106 -73.5	47756 -78.4	46424 -82.4	45131 -85.4	43895 -87.2	42730 -87.8	41650 -87.5	40664 -88.4	-65
-70	56018 -65.9	54964 -69.1	53876 -72.6	52762 -76.0	51635 -79.2	50509 -82.1	49397 -84.4	48312 -86.1	47266 -87.1	46271 -87.5	45334 -87.3	44464 -86.7	-70
-75	57152 -75.9	56323 -77.8	55471 -79.6	54604 -81.7	53728 -83.0	52854 -84.4	51988 -85.5	51140 -86.3	50317 -86.8	49525 -87.0	48772 -86.9	48063 -86.6	-75
-80	57615 -81.2	57038 -82.1	56448 -83.0	55849 -83.7	55246 -84.5	54643 -85.1	54045 -85.5	53458 -85.9	52884 -86.1	52330 -86.2	51799 -86.2	51295 -86.0	-80
-85	57375 -82.3	57075 -82.7	56768 -83.1	56457 -83.4	56145 -83.7	55833 -83.9	55523 -84.1	55219 -84.2	54921 -84.4	54633 -84.4	54356 -84.5	54093 -84.5	-85
-90	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	-90
LAT / E. LONG	240	245	250	255	260	265	270	275	280	285	290	295	LAT / E. LONG

TOTAL INTENSITY (F) WMM-90

E. LONG / LAT	300	305	310	315	320	325	330	335	340	345	350	355	E. LONG / LAT
0	29299 -70.5	28717 -66.7	28206 -56.3	27830 -45.9	27632 -31.2	27640 -16.7	27850 -3.0	28229 6.9	28732 12.9	29315 15.1	29947 14.1	30604 10.7	0
-5	27786 -58.2	26939 -53.7	26499 -45.1	26308 -33.2	26300 -19.7	26485 -6.4	26848 4.8	27357 12.5	27969 16.5	28651 16.3	29376 14.1	30124 8.9	-5
-10	25664 -40.8	25333 -41.6	25144 -33.2	25121 -22.6	25273 -11.1	25595 -.4	26064 8.0	26650 11.2	27321 15.0	28053 13.6	28827 9.4	29625 2.9	-10
-15	24468 -38.1	24222 -32.5	24151 -24.7	24258 -15.8	24529 -7.0	24941 .6	25467 5.8	26080 8.2	26757 7.7	27485 4.6	28249 -.9	29034 -8.2	-15
-20	23711 -33.4	23508 -27.8	23513 -20.8	23703 -13.9	24048 -7.9	24508 -3.7	25051 -1.9	25650 -2.5	26289 -5.3	26959 -10.2	27653 -16.8	28354 -24.7	-20
-25	23394 -33.2	23191 -27.5	23224 -21.7	23445 -16.8	23818 -13.6	24287 -12.6	24813 -14.0	25366 -17.6	25931 -23.0	26501 -29.8	27072 -37.5	27632 -45.7	-25
-30	23529 -37.5	23281 -32.0	23283 -27.2	23488 -24.0	23839 -23.1	24275 -24.9	24749 -29.2	25226 -35.6	25689 -43.5	26132 -52.2	26551 -61.0	26943 -69.4	-30
-35	24150 -45.4	23820 -40.1	23742 -36.1	23871 -34.2	24143 -35.1	24496 -39.0	24876 -45.6	25247 -54.3	25587 -64.2	25891 -74.4	26160 -84.1	26394 -92.4	-35
-40	25312 -55.2	24872 -50.4	24673 -47.0	24672 -46.0	24811 -48.0	25029 -53.1	25275 -61.0	25512 -71.0	25718 -82.1	25890 -93.1	26030 -103.1	26149 -110.6	-40
-45	27075 -65.1	26516 -60.9	26169 -58.0	26005 -57.5	25972 -59.9	26019 -65.3	26104 -73.3	26192 -83.3	26267 -94.3	26326 -105.0	26375 -114.2	26430 -120.8	-45
-50	29471 -73.5	28797 -69.9	28309 -67.5	27977 -67.2	27766 -69.3	27637 -74.0	27558 -81.0	27504 -89.8	27463 -99.2	27436 -108.3	27431 -116.0	27464 -121.0	-50
-55	32471 -79.5	31714 -76.6	31109 -74.6	30637 -74.1	30276 -75.5	29994 -79.0	29777 -84.2	29607 -90.7	29477 -97.7	29391 -104.5	29357 -110.0	29391 -113.4	-55
-60	35967 -83.1	35169 -80.9	34494 -79.2	33929 -78.6	33462 -79.1	33077 -81.1	32764 -84.2	32515 -88.3	32327 -92.7	32205 -97.0	32155 -100.4	32190 -102.4	-60
-65	39776 -84.9	38987 -83.3	38294 -82.0	37694 -81.2	37178 -81.2	36742 -81.9	36381 -83.3	36091 -85.3	35876 -87.5	35733 -89.7	35673 -91.4	35704 -92.4	-65
-70	43664 -85.7	42937 -84.7	42285 -83.8	41707 -83.0	41201 -82.6	40766 -82.6	40403 -82.9	40111 -83.5	39892 -84.2	39749 -84.9	39687 -85.5	39710 -85.8	-70
-75	47602 -86.1	46793 -85.5	46238 -84.9	45740 -84.5	45299 -83.9	44918 -83.5	44598 -83.3	44341 -83.2	44148 -83.2	44023 -83.2	43969 -83.1	43987 -83.0	-75
-80	50821 -85.8	50380 -85.6	49976 -85.3	49611 -85.0	49287 -84.6	49006 -84.3	48771 -84.0	48582 -83.7	48443 -83.4	48355 -83.2	48319 -82.9	48336 -82.6	-80
-85	53845 -84.4	53614 -84.3	53403 -84.2	53211 -84.1	53042 -84.0	52897 -83.8	52776 -83.6	52680 -83.4	52611 -83.2	52570 -83.0	52557 -82.7	52571 -82.5	-85
-90	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	56497 -80.7	-90
LAT / E. LONG	300	305	310	315	320	325	330	335	340	345	350	355	LAT / E. LONG

TOTAL INTENSITY (F) WMM-90

E. LONG / LAT	0	5	10	15	20	25	30	35	40	45	50	55	E. LONG / LAT
90	-32.2 14.8	-27.2 14.8	-22.2 14.8	-17.2 14.8	-12.2 14.8	-7.2 14.8	-2.2 14.8	2.8 14.8	7.8 14.8	12.8 14.8	17.8 14.8	22.8 14.8	90
85	-16.3 10.4	-11.7 10.2	-7.2 9.9	-2.8 9.7	1.6 9.5	5.9 9.4	10.1 9.3	14.2 9.2	18.2 9.1	22.1 9.1	25.9 9.0	29.6 9.0	85
80	-12.3 8.9	-8.0 8.4	-3.8 8.0	.3 7.7	4.3 7.3	8.3 7.0	12.2 6.8	15.9 6.6	19.5 6.5	22.9 6.3	26.2 6.3	29.2 6.2	80
75	-10.4 8.3	-6.5 7.6	-2.7 7.0	1.1 6.5	4.8 6.0	8.3 5.6	11.6 5.2	15.1 4.9	18.2 4.7	21.2 4.5	23.9 4.4	26.3 4.3	75
70	-9.0 7.9	-5.6 7.1	-2.1 6.4	1.2 5.7	4.6 5.1	7.5 4.5	10.5 4.1	13.3 3.7	16.0 3.4	18.4 3.2	20.6 3.0	22.5 2.9	70
65	-7.7 7.6	-4.7 6.7	-1.7 5.9	1.1 5.1	3.8 4.4	6.4 3.7	8.9 3.2	11.3 2.8	13.4 2.4	15.4 2.2	17.1 2.0	18.5 1.9	65
60	-6.4 7.3	-3.9 6.4	-1.3 5.5	1.1 4.6	3.3 3.9	5.4 3.1	7.4 2.5	9.2 2.0	11.0 1.6	12.5 1.4	13.8 1.2	14.8 1.1	60
55	-5.2 7.0	-3.0 6.1	-.9 5.3	1.1 4.4	2.9 3.5	4.5 2.7	6.1 2.0	7.5 1.4	8.8 1.0	9.9 .7	10.8 .5	11.5 .5	55
50	-4.2 6.8	-2.3 6.0	-.5 5.2	1.1 4.4	2.5 3.3	3.8 2.5	5.0 1.6	6.0 1.0	6.9 .5	7.7 .1	8.3 .0	8.8 .0	50
45	-3.5 6.7	-1.8 6.0	-.2 5.2	1.1 4.2	2.2 3.3	3.2 2.3	4.1 1.4	4.8 .6	5.5 .1	5.9 -.3	6.3 -.4	6.5 -.3	45
40	-3.0 6.7	-1.5 6.0	-.1 5.2	1.0 4.1	1.9 3.2	2.7 2.2	3.4 1.3	3.9 .5	4.3 -.1	4.6 -.5	4.7 -.6	4.7 -.5	40
35	-2.8 6.6	-1.4 6.0	-.2 5.2	.8 4.2	1.6 3.2	2.2 2.2	2.8 1.2	3.2 .4	3.5 -.1	3.6 -.4	3.5 -.5	3.3 -.4	35
30	-2.8 6.6	-1.5 6.0	-.4 5.2	.5 4.3	1.2 3.2	1.8 2.2	2.3 1.3	2.7 .6	2.9 .1	2.8 -.2	2.6 -.3	2.2 -.7	30
25	-3.1 6.6	-1.7 6.0	-.7 5.2	.1 4.3	.8 3.3	1.4 2.3	1.9 1.5	2.2 .8	2.4 .4	2.3 .1	1.9 .1	1.4 .1	25
20	-3.5 6.8	-2.2 6.0	-1.2 5.2	-.4 4.4	.3 3.4	.9 2.5	1.5 1.8	1.9 1.7	2.0 .8	1.8 .5	1.2 .4	.7 .5	20
15	-4.2 6.8	-2.9 6.1	-1.8 5.4	-.9 4.5	-.2 3.6	.5 2.8	1.1 2.1	1.5 1.6	1.6 1.2	1.4 .9	.8 .7	.0 .7	15
10	-5.2 7.0	-3.8 6.4	-2.9 5.9	-1.7 4.8	-.8 4.0	.0 3.2	.7 2.5	1.1 1.8	1.3 1.5	.9 1.1	.3 .9	-.7 .7	10
5	-6.6 7.4	-5.1 6.9	-3.7 6.2	-2.6 5.3	-1.6 4.5	-.6 3.7	.2 3.0	.6 2.3	.6 1.7	.2 1.2	-.7 .7	-1.7 .4	5
0	-8.5 8.0	-6.9 7.5	-5.2 6.9	-3.9 6.1	-2.6 5.2	-1.4 4.3	-.5 3.4	-.1 2.5	-.2 1.6	-.8 .9	-1.9 .3	-3.0 -.1	0
LAT / E. LONG	0	5	10	15	20	25	30	35	40	45	50	55	LAT / E. LONG

TOTAL INTENSITY (F) WMM-90

E. LONG LAT	60	65	70	75	80	85	90	95	100	105	110	115	E. LONG LAT
90	27.8 14.8	32.8 14.8	37.8 14.8	42.8 14.8	47.8 14.8	52.8 14.8	57.8 14.8	62.8 14.8	67.8 14.8	72.8 14.8	77.8 14.8	82.8 14.8	90
85	33.0 9.0	36.3 9.0	39.4 9.1	42.2 9.0	44.7 9.0	46.9 8.8	48.6 8.5	49.7 8.0	50.3 7.3	50.2 6.1	49.4 4.5	47.4 2.2	85
80	31.9 6.2	34.3 6.1	36.3 6.0	37.7 5.9	38.4 5.5	38.2 4.9	36.9 3.9	34.2 2.2	29.9 -.3	24.0 -3.6	17.0 -7.1	9.8 -9.9	80
75	26.4 4.2	30.0 4.1	31.0 4.0	31.4 3.7	30.8 3.2	29.1 2.4	26.0 1.2	21.4 -.7	15.3 -3.1	8.3 -5.5	1.3 -7.4	-5.0 -8.3	75
70	24.0 2.8	24.9 2.7	25.3 2.6	25.0 2.4	23.7 1.9	21.4 1.2	17.9 .2	13.2 -1.1	7.6 -2.6	1.6 -4.1	-4.2 -5.1	-9.2 -5.6	70
65	19.5 1.8	20.1 1.8	20.1 1.7	19.4 1.6	18.0 1.3	15.6 .9	12.4 .3	8.3 -.6	3.7 -1.5	-1.2 -2.4	-5.9 -3.2	-9.9 -3.6	65
60	15.5 1.1	15.8 1.1	15.6 1.2	14.8 1.2	13.4 1.1	11.4 .9	8.7 .6	5.3 .1	1.6 -.5	-2.3 -1.1	-6.1 -1.7	-9.5 -2.2	60
55	12.0 .8	12.1 .7	11.8 .9	11.1 1.0	9.9 1.1	8.2 1.1	6.0 1.0	3.4 .7	.4 .3	-2.7 -.2	-5.8 -.7	-8.6 -1.2	55
50	9.0 .2	9.0 .4	8.7 .7	8.1 1.0	7.1 1.2	5.8 1.3	4.1 1.3	2.0 1.1	-.3 .8	-2.7 .4	-5.2 -.1	-7.6 -.6	50
45	6.5 -.1	6.4 .2	6.1 .6	5.6 1.0	4.9 1.3	3.9 1.5	2.6 1.5	1.1 1.4	-.7 1.1	-2.6 .7	-4.6 .3	-6.5 -.2	45
40	4.6 -.2	4.3 .2	4.0 .6	3.6 1.0	3.1 1.3	2.4 1.5	1.5 1.6	.4 1.5	-.9 1.2	-2.3 .8	-3.9 .3	-5.4 -.2	40
35	3.0 -.1	2.7 .2	2.4 .6	2.0 1.0	1.7 1.3	1.2 1.5	.6 1.5	-.1 1.4	-1.0 1.1	-2.0 .7	-3.2 .2	-4.4 -.3	35
30	1.8 .0	1.4 .4	1.1 .7	.8 1.0	.5 1.3	.3 1.4	-.1 1.4	-.5 1.2	-1.0 .9	-1.7 .4	-2.5 -.1	-3.4 -.6	30
25	.8 .3	.3 .5	.0 .8	-.2 1.0	-.4 1.2	-.5 1.3	-.6 1.2	-.7 .9	-.9 .5	-1.3 .0	-1.8 -.5	-2.5 -1.0	25
20	.0 .5	-.5 .7	-.9 .8	-1.1 1.0	-1.2 1.1	-1.1 1.0	-1.0 .9	-.9 .6	-.8 .2	-.9 -.3	-1.6 -.9	-1.6 -1.4	20
15	-.7 .7	-1.3 .7	-1.7 .8	-1.9 .8	-1.9 .9	-1.7 .8	-1.4 .6	-1.0 .3	-.7 -.1	-.6 -.7	-.9 -1.2	-.8 -1.7	15
10	-1.6 .8	-2.2 .6	-2.6 .6	-2.7 .6	-2.6 .6	-2.3 .6	-1.8 .4	-1.2 .1	-.7 -.4	-.3 -.9	-.1 -1.5	-.1 -1.9	10
5	-2.6 .3	-3.3 .2	-3.7 .3	-3.7 .3	-3.5 .4	-3.0 .4	-2.3 .2	-1.5 -.1	-.7 -.5	-.1 -1.0	-.3 -1.5	-.5 -1.9	5
0	-4.0 -.3	-4.7 -.3	-5.1 -.1	-5.0 .0	-4.6 .2	-3.9 .2	-3.4 .1	-1.9 -.2	-.9 -.5	-.1 -.9	-.5 -1.3	-.9 -1.7	0
LAT E. LONG	60	65	70	75	80	85	90	95	100	105	110	115	LAT E. LONG

DECLINATION (D) WMM-90

E. LONG / LAT	120	125	130	135	140	145	150	155	160	165	170	175	E. LONG / LAT
90	87.8 14.8	92.8 14.8	97.8 14.8	102.8 14.8	107.8 14.8	112.8 14.8	117.8 14.8	122.8 14.8	127.8 14.8	132.8 14.8	137.8 14.8	142.8 14.6	90
85	45.5 -.6	42.6 -3.7	39.8 -6.9	38.8 -8.7	34.6 -12.0	32.7 -13.6	31.9 -14.6	31.9 -15.1	32.6 -15.4	34.5 -15.5	38.9 -15.6	49.9 -15.7	85
80	3.6 -11.5	-1.5 -11.7	-4.7 -11.1	-6.4 -10.1	-6.8 -9.1	-6.1 -8.1	-4.6 -7.2	-2.5 -6.5	.6 -5.9	3.3 -5.5	6.7 -5.2	10.3 -5.1	80
75	-9.8 -8.3	-12.9 -7.7	-14.6 -6.9	-15.1 -6.0	-14.4 -5.1	-13.0 -4.3	-11.9 -3.7	-8.4 -3.1	-5.6 -2.7	-2.1 -2.4	1.6 -2.3	5.1 -2.2	75
70	-12.9 -5.6	-15.4 -5.3	-16.6 -4.7	-16.7 -4.1	-15.9 -3.4	-14.5 -2.9	-12.4 -2.3	-9.8 -1.9	-6.6 -1.6	-3.6 -1.4	-.1 -1.3	3.5 -1.3	70
65	-13.1 -3.8	-15.1 -3.7	-16.2 -3.4	-16.3 -3.0	-15.6 -2.6	-14.2 -2.2	-12.2 -1.8	-9.8 -1.5	-7.0 -1.2	-3.8 -1.1	-.6 -1.0	3.0 -1.1	65
60	-12.1 -2.5	-14.0 -2.6	-15.0 -2.5	-15.2 -2.4	-14.6 -2.2	-13.3 -1.9	-11.5 -1.6	-9.2 -1.4	-6.5 -1.2	-3.5 -1.1	-.4 -1.1	2.9 -1.2	60
55	-10.9 -1.6	-12.5 -1.8	-13.5 -1.9	-13.7 -2.0	-13.2 -1.9	-12.0 -1.8	-10.4 -1.7	-8.2 -1.6	-5.7 -1.5	-2.9 -1.4	.1 -1.4	3.1 -1.5	55
50	-9.5 -1.0	-11.0 -1.5	-11.8 -1.6	-12.1 -1.7	-11.6 -1.8	-10.6 -1.8	-9.0 -1.9	-7.0 -1.9	-4.7 -1.8	-2.0 -1.8	.7 -1.8	3.6 -1.8	50
45	-8.2 -.7	-9.6 -1.0	-10.2 -1.3	-10.4 -1.5	-10.0 -1.7	-9.0 -1.8	-7.5 -2.0	-5.4 -2.1	-3.4 -2.2	-.9 -2.2	1.6 -2.2	4.2 -2.1	45
40	-6.8 -.6	-7.9 -.9	-8.5 -1.2	-8.7 -1.4	-8.2 -1.6	-7.3 -1.7	-5.9 -1.9	-4.0 -2.1	-1.9 -2.3	.4 -2.4	2.7 -2.4	5.1 -2.3	40
35	-5.5 -.7	-6.6 -1.0	-6.9 -1.2	-6.9 -1.3	-6.4 -1.4	-5.5 -1.5	-4.1 -1.6	-2.4 -1.8	-.3 -2.0	1.8 -2.2	4.0 -2.4	6.1 -2.4	35
30	-4.3 -1.0	-4.9 -1.2	-5.3 -1.3	-5.3 -1.5	-4.7 -1.1	-3.7 -1.1	-2.3 -1.1	-.6 -1.7	1.3 -1.5	3.3 -1.8	5.3 -2.0	7.1 -2.3	30
25	-3.1 -1.3	-3.6 -1.5	-3.7 -1.4	-3.5 -1.1	-2.8 -.8	-1.9 -.5	-.5 -.4	1.1 -.4	2.9 -.6	4.8 -1.0	6.6 -1.5	8.1 -2.0	25
20	-2.9 -1.7	-2.3 -1.7	-2.3 -1.5	-2.0 -1.1	-1.2 -.5	-.2 .0	1.2 .4	2.8 .5	4.5 .3	6.1 -.2	7.6 -.9	8.9 -1.6	20
15	-1.0 -1.9	-1.1 -1.9	-1.0 -1.6	-.5 -1.0	.3 -.3	1.4 .4	2.7 1.0	4.2 1.2	5.8 1.1	7.3 .5	8.6 -.3	9.5 -1.4	15
10	-.2 -2.1	-.1 -2.0	.2 -1.6	.8 -.8	1.6 -.1	2.8 .7	4.0 1.4	5.4 1.7	6.8 1.6	8.1 1.0	9.2 .1	9.9 -1.1	10
5	.6 -2.0	.8 -1.8	1.2 -1.5	1.9 -.8	2.8 .0	3.9 .9	5.1 1.5	6.4 1.9	7.6 1.8	8.8 1.2	9.7 .3	10.2 -.6	5
0	1.2 -1.8	1.5 -1.7	2.0 -1.3	2.8 -.7	3.7 .0	4.8 .8	5.9 1.4	7.1 1.7	8.3 1.6	9.3 1.2	10.1 .3	10.5 -.7	0
LAT / E. LONG	120	125	130	135	140	145	150	155	160	165	170	175	LAT / E. LONG

Deg.
(units : min/yr)

E. LONG / LAT	180	185	190	195	200	205	210	215	220	225	230	235	E. LONG / LAT
90	147.8 14.8	152.8 14.8	157.8 14.8	162.8 14.8	167.8 14.8	172.8 14.8	177.8 14.8	-177.2 14.8	-172.2 14.8	-167.2 14.8	-162.2 14.8	-157.2 14.8	90
85	43.5 -15.9	47.8 -16.2	52.7 -16.6	58.2 -17.2	64.5 -17.9	71.6 -18.5	80.0 -18.9	89.9 -18.6	101.8 -16.6	116.3 -11.5	133.6 -1.7	153.0 11.6	85
80	14.2 -5.1	18.3 -5.3	22.6 -5.6	26.7 -6.1	31.2 -6.8	35.7 -7.7	40.6 -9.0	45.2 -10.6	50.1 -12.7	55.3 -15.5	60.8 -19.8	67.0 -25.6	80
75	9.0 -2.3	12.9 -2.6	16.9 -3.0	21.0 -3.5	25.0 -4.2	29.0 -5.0	32.9 -6.1	36.7 -7.4	40.3 -9.1	43.8 -11.2	46.9 -14.0	49.6 -17.8	75
70	7.2 -1.5	11.0 -1.9	14.8 -2.3	18.5 -2.9	22.2 -3.7	25.7 -4.6	29.0 -5.7	32.2 -6.9	35.0 -8.4	37.4 -10.1	39.4 -12.2	40.7 -14.8	70
65	6.5 -1.4	10.1 -1.7	13.6 -2.2	17.0 -2.9	20.3 -3.7	23.3 -4.6	26.2 -5.7	28.7 -6.8	30.8 -8.1	32.5 -9.5	33.6 -11.0	34.0 -12.6	65
60	6.2 -1.4	9.6 -1.8	12.8 -2.3	15.9 -2.9	18.8 -3.7	21.6 -4.6	23.7 -5.5	25.7 -6.5	27.3 -7.6	28.6 -8.6	28.9 -9.6	28.8 -10.5	60
55	6.2 -1.6	9.3 -1.9	12.2 -2.5	14.9 -2.8	17.4 -3.5	19.7 -4.5	21.6 -5.1	23.1 -6.0	24.2 -6.8	24.9 -7.6	25.1 -8.2	24.7 -8.6	55
50	6.4 -1.9	9.1 -2.0	11.7 -2.2	14.1 -2.6	16.3 -3.1	18.1 -3.8	19.7 -4.5	20.8 -5.3	21.6 -5.9	22.0 -6.5	22.0 -6.8	21.6 -6.9	50
45	6.8 -2.1	9.2 -2.0	11.6 -2.1	13.5 -2.3	15.2 -2.7	16.7 -3.2	17.9 -3.8	18.8 -4.4	19.6 -5.0	19.6 -5.3	19.5 -5.5	19.0 -5.4	45
40	7.3 -2.2	9.4 -2.1	11.3 -2.0	12.9 -2.1	14.3 -2.3	15.6 -2.6	16.3 -3.1	17.0 -3.6	17.6 -4.0	17.5 -4.2	17.4 -4.3	17.0 -4.1	40
35	8.0 -2.3	9.7 -2.2	11.1 -2.1	12.3 -2.0	13.3 -2.0	14.2 -2.2	14.8 -2.5	15.3 -2.8	15.6 -3.1	15.7 -3.2	15.5 -3.1	15.1 -2.8	35
30	8.7 -2.4	10.2 -2.4	11.0 -2.3	11.7 -2.2	12.4 -2.1	12.9 -2.1	13.4 -2.2	13.7 -2.2	13.9 -2.2	14.0 -2.1	13.8 -1.8	13.5 -1.5	30
25	9.3 -2.4	10.2 -2.7	10.8 -2.8	11.1 -2.7	11.6 -2.6	11.7 -2.5	12.0 -2.0	12.3 -1.7	12.4 -1.3	12.4 -.9	12.3 -.5	12.1 -.1	25
20	9.8 -2.4	10.3 -3.0	10.5 -3.3	10.5 -3.4	10.9 -3.1	10.7 -2.6	10.8 -2.0	11.0 -1.5	11.1 -.5	11.1 .3	11.0 .9	10.8 1.5	20
15	10.1 -2.4	10.3 -3.3	10.2 -3.8	10.0 -4.0	9.9 -3.7	9.8 -2.9	9.9 -2.0	10.0 -.8	10.0 .4	10.0 1.4	9.9 2.2	9.8 2.7	15
10	10.3 -2.3	10.3 -3.4	10.0 -4.1	9.7 -4.3	9.6 -3.6	9.3 -3.0	9.3 -1.2	9.3 -.3	9.3 1.2	9.3 2.5	9.2 3.5	9.1 3.9	10
5	10.4 -2.2	10.3 -3.2	9.9 -3.9	9.5 -4.1	9.2 -3.8	9.1 -2.8	9.0 -1.4	9.0 .5	9.0 2.0	9.0 3.5	8.9 4.5	8.8 4.8	5
0	10.6 -1.8	10.4 -2.8	10.1 -3.4	9.7 -3.6	9.4 -3.2	9.2 -2.2	9.2 -.8	9.2 .9	9.1 2.7	9.1 4.2	9.0 5.2	8.9 5.5	0
LAT / E. LONG	180	185	190	195	200	205	210	215	220	225	230	235	LAT / E. LONG

DECLINATION (D) WMM-90

E. LONG / LAT	240	245	250	255	260	265	270	275	280	285	290	295	E. LONG / LAT
90	-152.2 14.8	-147.2 14.8	-142.2 14.8	-137.2 14.8	-132.2 14.8	-127.2 14.8	-122.2 14.8	-117.2 14.8	-112.2 14.8	-107.2 14.8	-102.2 14.8	-97.2 14.8	90
85	172.5 23.6	-169.9 30.4	-156.7 32.3	-143.1 31.1	-131.5 29.3	-122.3 27.0	-114.2 24.9	-106.8 23.0	-100.0 21.3	-93.6 19.8	-87.5 18.6	-81.6 17.6	85
80	74.4 -35.6	65.1 -54.4	109.7 -84.2	-163.5 149.5	-121.5 90.7	-107.9 56.5	-99.6 41.3	-93.0 33.0	-87.3 27.7	-81.9 24.1	-76.8 21.5	-71.8 19.6	80
75	51.5 -23.3	51.9 -32.2	48.9 -47.9	35.7 -75.5	-9.6 -36.2	-54.5 48.0	-67.6 43.5	-70.5 35.0	-70.0 29.1	-68.0 25.1	-65.3 22.3	-62.0 20.2	75
70	40.9 -18.0	39.4 -22.2	35.2 -27.3	26.0 -31.8	9.3 -27.8	-13.6 -7.6	-33.3 12.1	-45.0 19.7	-50.6 20.9	-52.8 20.2	-52.9 19.2	-51.7 18.1	70
65	33.4 -14.3	31.4 -16.2	27.4 -17.9	20.7 -18.5	10.6 -16.6	-2.4 -10.5	-19.0 -1.7	-27.2 5.8	-36.8 10.3	-39.6 12.6	-41.6 13.8	-42.1 14.1	65
60	27.9 -11.3	25.8 -11.9	22.4 -12.3	17.3 -12.1	10.2 -10.9	1.5 -8.4	-8.1 -4.7	-17.0 -.4	-24.3 3.3	-29.4 6.2	-32.6 8.3	-34.2 9.7	60
55	23.7 -8.8	21.9 -8.8	19.0 -8.7	15.0 -8.3	9.7 -7.7	3.2 -6.7	-4.0 -5.1	-11.1 -3.0	-17.5 .5	-22.5 1.9	-26.0 4.2	-28.1 6.1	55
50	20.6 -6.8	19.0 -6.6	16.6 -6.3	13.4 -6.0	9.2 -5.8	4.1 -5.5	-1.6 -5.1	-7.5 -4.2	-13.0 -2.7	-17.7 -.9	-21.3 1.2	-23.6 3.3	50
45	18.2 -5.2	16.8 -4.8	14.8 -4.5	12.2 -4.4	8.8 -4.5	4.7 -4.8	-.1 -5.1	-5.1 -4.9	-10.0 -4.2	-14.3 -2.8	-17.9 -.9	-20.3 1.2	45
40	16.2 -3.8	15.0 -3.4	13.4 -3.2	11.2 -3.3	8.4 -3.7	5.0 -4.4	1.0 -5.2	-3.4 -5.6	-7.8 -5.4	-11.9 -4.4	-15.3 -2.7	-17.9 -.6	40
35	14.5 -2.5	13.6 -2.2	12.2 -2.2	10.4 -2.5	8.1 -3.2	5.2 -4.3	1.7 -5.4	-2.1 -6.2	-6.1 -6.4	-9.9 -5.7	-13.3 -4.2	-16.0 -2.2	35
30	13.0 -1.2	12.3 -1.0	11.6 -1.2	9.7 -1.8	7.8 -2.8	5.3 -4.2	2.3 -5.7	-1.1 -6.8	-4.7 -7.4	-8.6 -7.0	-11.7 -5.7	-14.5 -3.7	30
25	11.7 .2	11.1 .1	10.3 -.3	9.1 -1.2	7.5 -2.5	5.4 -4.2	2.8 -6.0	-.2 -7.4	-3.6 -8.2	-7.0 -8.1	-10.4 -7.1	-13.3 -5.2	25
20	10.5 1.5	10.2 1.2	9.6 .5	8.7 -.7	7.4 -2.3	5.7 -4.3	3.4 -6.3	-.6 -8.0	-2.5 -9.0	-5.9 -9.2	-8.3 -8.5	-12.2 -6.6	20
15	9.7 2.7	9.4 2.3	9.1 1.2	8.5 -.3	7.5 -2.2	6.0 -4.4	4.0 -6.6	1.4 -8.4	-1.6 -9.7	-4.8 -10.0	-8.1 -9.4	-11.3 -8.0	15
10	9.1 3.8	9.0 3.1	8.8 1.8	8.4 .0	7.2 -2.2	6.4 -4.5	4.6 -6.8	2.3 -8.8	-.6 -10.1	-3.8 -10.7	-7.2 -10.3	-10.5 -9.1	10
5	8.8 4.6	8.8 3.7	6.8 2.1	8.6 .0	8.0 -2.3	6.9 -4.7	5.3 -7.1	3.1 -9.0	.3 -10.4	-2.9 -11.1	-6.3 -10.9	-9.7 -9.9	5
0	6.9 5.1	9.0 3.9	9.0 2.1	8.9 -.1	8.4 -2.6	7.6 -5.0	6.1 -7.3	4.0 -9.2	1.3 -10.6	-1.9 -11.3	-5.4 -11.3	-9.0 -10.5	0
LAT / E. LONG	240	245	250	255	260	265	270	275	280	285	290	295	LAT / E. LONG

E. LONG LAT	300	305	310	315	320	325	330	335	340	345	350	355	E. LONG LAT
90	-92.2 14.8	-87.2 14.8	-82.2 14.8	-77.2 14.8	-72.2 14.8	-67.2 14.8	-62.2 14.8	-57.2 14.8	-52.2 14.8	-47.2 14.8	-42.2 14.8	-37.2 14.8	90
85	-76.0 16.6	-70.5 15.8	-65.2 15.0	-60.0 14.3	-54.8 13.7	-49.8 13.2	-44.8 12.7	-39.9 12.2	-35.0 11.8	-30.3 11.4	-25.5 11.0	-20.9 10.7	85
80	-67.0 18.0	-62.2 16.7	-57.4 15.6	-52.8 14.6	-48.1 13.8	-43.5 13.0	-38.9 12.3	-34.4 11.6	-29.9 11.0	-25.4 10.4	-21.0 9.9	-16.6 9.4	80
75	-58.5 18.5	-54.8 17.2	-50.9 16.1	-47.0 15.1	-43.0 14.3	-38.9 13.4	-34.8 12.6	-30.7 11.9	-26.6 11.1	-22.5 10.4	-18.4 9.6	-14.4 8.9	75
70	-49.8 17.2	-47.3 16.4	-44.6 15.6	-41.2 14.9	-37.9 14.2	-34.6 13.5	-30.8 12.8	-27.2 12.0	-23.5 11.2	-19.8 10.4	-16.2 9.6	-12.6 8.7	70
65	-41.5 14.2	-40.1 14.2	-38.1 14.1	-35.7 13.8	-32.9 13.5	-30.0 13.0	-26.9 12.5	-23.7 11.8	-20.5 11.1	-17.2 10.2	-14.0 9.4	-10.8 8.5	65
60	-34.5 10.8	-33.9 11.5	-32.6 12.0	-30.7 12.2	-28.5 12.3	-26.0 12.1	-23.3 11.8	-20.5 11.2	-17.6 10.6	-14.8 9.9	-11.9 9.0	-9.1 8.2	60
55	-29.0 7.7	-28.9 9.0	-28.1 9.9	-26.6 10.6	-24.8 10.9	-22.6 11.0	-20.2 10.9	-17.8 10.5	-15.2 10.0	-12.6 9.4	-10.1 8.6	-7.6 7.8	55
50	-24.9 5.2	-25.1 6.9	-24.6 8.1	-23.4 9.1	-21.8 9.7	-19.9 10.0	-17.8 10.0	-15.6 9.8	-13.2 9.4	-10.9 8.9	-8.6 8.3	-6.4 7.6	50
45	-21.8 3.3	-22.1 5.1	-22.0 6.7	-21.1 7.8	-19.7 8.6	-17.9 9.0	-16.0 9.2	-13.9 9.1	-11.8 8.8	-9.6 8.4	-7.5 7.9	-5.4 7.4	45
40	-19.5 1.6	-20.3 3.7	-20.2 5.4	-19.4 6.8	-18.2 7.7	-16.6 8.2	-14.8 8.5	-12.9 8.4	-10.8 8.3	-8.8 8.0	-6.8 7.7	-4.8 7.2	40
35	-17.8 .1	-18.8 2.3	-19.0 4.2	-18.4 5.8	-17.3 6.8	-15.9 7.5	-14.1 7.8	-12.3 7.9	-10.3 7.9	-8.3 7.7	-6.4 7.4	-4.5 7.1	35
30	-16.5 -1.4	-17.9 1.0	-18.2 3.1	-17.9 4.8	-17.0 6.0	-15.6 6.8	-14.0 7.3	-12.2 7.5	-10.2 7.5	-8.3 7.5	-6.3 7.3	-4.5 7.0	30
25	-15.5 -2.9	-17.0 -.4	-17.8 1.8	-17.7 3.7	-17.1 5.1	-15.9 6.1	-14.3 6.8	-12.5 7.1	-10.5 7.3	-8.5 7.3	-6.5 7.2	-4.7 7.0	25
20	-14.7 -4.4	-16.5 -1.9	-17.6 .5	-17.9 2.5	-17.5 4.2	-16.5 5.4	-15.0 6.2	-13.2 6.8	-11.2 7.1	-9.1 7.3	-7.0 7.2	-5.1 7.0	20
15	-14.0 -5.9	-16.2 -3.4	-17.6 -1.0	-18.3 1.2	-18.2 3.1	-17.4 4.5	-16.0 5.7	-14.2 6.4	-12.2 7.0	-10.0 7.3	-7.8 7.3	-5.9 7.2	15
10	-13.5 -7.2	-15.9 -4.9	-17.7 -2.5	-18.7 -.2	-19.0 1.9	-18.4 3.6	-17.2 5.0	-15.5 6.1	-13.5 6.8	-11.2 7.3	-9.0 7.5	-7.0 7.4	10
5	-12.9 -8.3	-15.7 -6.2	-17.9 -3.9	-19.3 -1.6	-19.9 .6	-19.6 2.5	-18.7 4.2	-17.1 5.6	-15.1 6.6	-12.8 7.3	-10.6 7.7	-8.5 7.7	5
0	-12.4 -9.2	-15.5 -7.3	-18.0 -5.2	-19.7 -3.0	-20.7 -.8	-20.8 1.3	-20.2 3.2	-18.8 4.9	-17.0 6.3	-14.8 7.3	-12.6 7.9	-10.5 8.1	0
LAT E. LONG	300	305	310	315	320	325	330	335	340	345	350	355	LAT E. LONG

DECLINATION (D) WMM-90

E. LONG LAT	0	5	10	15	20	25	30	35	40	45	50	55	E. LONG LAT
0	-8.5 8.0	-6.8 7.5	-5.6 6.9	-3.2 6.1	-2.6 5.2	-1.4 4.3	-.5 3.4	-.1 2.4	-.2 1.6	-.8 .9	-1.9 .3	-3.0 -.1	0
-5	-10.9 8.5	-9.0 8.3	-7.2 7.8	-5.5 7.0	-3.9 6.1	-2.5 5.0	-1.6 3.7	-1.2 2.4	-1.5 1.2	-2.4 .2	-3.7 -.6	-5.6 -1.0	-5
-10	-13.8 8.9	-11.9 9.0	-9.7 8.7	-7.7 8.6	-5.8 6.9	-4.2 5.4	-3.2 3.7	-3.0 1.9	-3.6 .3	-4.9 -1.0	-6.4 -1.8	-7.8 -2.1	-10
-15	-17.1 8.9	-15.0 9.2	-12.8 9.2	-10.5 8.5	-8.3 7.3	-6.7 5.4	-5.8 3.1	-5.9 .7	-7.0 -1.3	-8.6 -2.7	-10.3 -3.3	-11.9 -3.2	-15
-20	-20.4 7.9	-18.4 8.6	-16.3 8.7	-13.8 8.1	-11.7 6.5	-10.2 4.1	-9.7 1.3	-10.3 -1.4	-11.8 -3.4	-13.8 -4.5	-15.7 -4.6	-17.2 -4.1	-20
-25	-23.1 6.2	-21.5 6.8	-19.6 6.8	-17.5 5.9	-15.8 4.0	-14.8 1.2	-14.9 -1.8	-16.2 -4.3	-18.1 -5.8	-20.3 -6.2	-22.3 -5.7	-23.7 -4.6	-25
-30	-24.9 4.4	-23.9 4.3	-22.4 3.7	-21.0 2.1	-20.0 -.3	-19.9 -3.1	-20.8 -5.7	-22.6 -7.4	-24.9 -8.0	-27.2 -7.6	-29.1 -6.6	-30.4 -5.2	-30
-35	-25.4 3.2	-24.9 2.1	-24.2 .3	-23.7 -2.0	-23.7 -4.8	-24.5 -7.4	-26.2 -9.3	-28.4 -10.1	-30.9 -10.0	-33.3 -9.1	-35.3 -7.8	-36.6 -6.3	-35
-40	-24.8 2.8	-24.9 .6	-25.0 -2.1	-25.5 -5.2	-26.4 -8.1	-28.0 -10.4	-30.2 -11.8	-32.7 -12.1	-35.5 -11.7	-38.0 -10.6	-40.2 -9.3	-41.9 -7.9	-40
-45	-23.5 2.9	-24.2 .0	-25.2 -3.2	-26.5 -6.5	-28.2 -9.4	-30.3 -11.6	-32.9 -12.8	-35.8 -13.2	-38.7 -12.8	-41.5 -11.9	-43.9 -10.6	-46.0 -9.6	-45
-50	-21.9 2.9	-23.3 .0	-25.0 -3.3	-27.0 -6.4	-29.3 -9.2	-31.9 -11.2	-34.8 -12.5	-37.9 -13.0	-41.0 -13.0	-44.0 -12.5	-46.8 -11.7	-49.3 -10.8	-50
-55	-20.5 2.7	-22.5 .1	-24.8 -2.7	-27.3 -5.5	-30.0 -7.9	-33.0 -9.8	-36.2 -11.1	-39.5 -11.9	-42.8 -12.2	-46.0 -12.0	-49.2 -11.6	-52.1 -11.1	-55
-60	-19.5 2.1	-22.0 .1	-24.7 -2.0	-27.6 -4.2	-30.7 -6.1	-33.9 -7.8	-37.3 -9.1	-40.8 -10.0	-44.3 -10.5	-47.8 -10.7	-51.3 -10.6	-54.6 -10.4	-60
-65	-19.0 1.5	-21.9 .1	-24.9 -1.4	-28.1 -3.0	-31.4 -4.4	-34.9 -5.7	-38.5 -6.8	-42.1 -7.7	-45.9 -8.3	-49.6 -8.7	-53.4 -9.0	-57.1 -9.0	-65
-70	-18.9 .8	-22.2 -.1	-25.5 -1.1	-29.0 -2.1	-32.5 -3.1	-36.2 -4.0	-40.0 -4.9	-43.8 -5.6	-47.8 -6.2	-51.7 -6.6	-55.7 -7.0	-59.8 -7.2	-70
-75	-19.5 .1	-23.1 -.4	-26.7 -1.0	-30.4 -1.6	-34.3 -2.2	-38.2 -2.8	-42.2 -3.3	-46.2 -3.9	-50.3 -4.3	-54.5 -4.8	-58.8 -5.1	-63.1 -5.4	-75
-80	-20.8 -.4	-24.8 -.7	-28.8 -1.0	-32.9 -1.3	-37.0 -1.7	-41.2 -2.0	-45.4 -2.3	-49.7 -2.6	-54.1 -3.0	-58.5 -3.2	-63.1 -3.5	-67.7 -3.8	-80
-85	-23.3 -.7	-27.7 -.8	-32.1 -1.0	-36.6 -1.1	-41.1 -1.3	-45.6 -1.4	-50.2 -1.6	-54.9 -1.7	-59.6 -1.8	-64.3 -2.0	-69.1 -2.1	-73.9 -2.2	-85
-90	-27.3 -.5	-32.3 -.5	-37.3 -.5	-42.3 -.5	-47.3 -.5	-52.3 -.5	-57.3 -.5	-62.3 -.5	-67.3 -.5	-72.3 -.5	-77.3 -.5	-82.3 -.5	-90
LAT E. LONG	0	5	10	15	20	25	30	35	40	45	50	55	LAT E. LONG

DECLINATION (D) WMM-90

E. LONG / LAT	60	65	70	75	80	85	90	95	100	105	110	115	LAT
0	-4.0 -.3	-4.7 -.3	-5.1 -.1	-5.0 .0	-4.6 .2	-3.9 .2	-3.0 .1	-1.9 -.2	-.9 -.5	-.1 -.9	.5 -1.3	.9 -1.7	0
-5	-6.1 -1.0	-6.8 -.9	-7.0 -.8	-6.8 -.2	-6.2 .0	-5.2 .2	-4.0 .1	-2.7 .6	-1.4 -.3	-.3 -.7	.6 -1.0	1.1 -1.2	-5
-10	-9.0 -1.9	-9.6 -1.4	-9.7 -.9	-9.3 -.3	-8.4 .1	-7.1 .3	-5.6 .4	-3.9 .3	-2.2 .1	-.8 -.2	.3 -.4	1.2 -.6	-10
-15	-13.0 -2.6	-13.4 -1.9	-13.3 -1.0	-12.6 -.3	-11.4 .3	-9.8 .6	-7.8 .8	-5.9 .7	-3.6 .6	-1.7 .4	-.2 .2	.9 .1	-15
-20	-18.2 -3.1	-18.4 -2.0	-18.0 -.9	-17.0 .0	-15.4 .6	-13.3 1.0	-10.9 1.2	-8.2 1.2	-5.6 1.1	-3.2 .9	-1.3 .8	.3 .7	-20
-25	-24.4 -3.4	-24.3 -2.0	-23.7 -.6	-22.3 .2	-20.4 .9	-17.9 1.3	-15.0 1.5	-11.8 1.5	-8.5 1.4	-5.5 1.3	-2.9 1.2	-.8 1.2	-25
-30	-31.0 -3.8	-30.9 -2.4	-30.1 -1.1	-28.6 -.1	-26.4 .6	-23.7 1.1	-20.3 1.3	-16.5 1.4	-12.6 1.4	-8.8 1.3	-5.4 1.3	-2.5 1.2	-30
-35	-37.4 -4.8	-37.4 -3.4	-36.7 -2.2	-35.3 -1.2	-33.3 -.4	-30.4 .2	-26.8 .5	-22.6 .6	-18.0 .7	-13.4 .8	-9.0 .9	-5.2 1.1	-35
-40	-42.9 -6.5	-43.3 -5.2	-43.1 -4.0	-42.2 -3.0	-40.5 -2.2	-38.0 -1.6	-34.6 -1.2	-30.3 -1.0	-25.3 -.8	-19.8 -.6	-14.4 -.2	-9.2 .3	-40
-45	-47.6 -6.3	-48.6 -7.2	-49.0 -6.1	-48.8 -5.2	-47.9 -4.4	-46.2 -3.9	-43.4 -3.6	-39.6 -3.4	-34.6 -3.2	-28.8 -2.9	-22.4 -2.5	-15.6 -1.4	-45
-50	-51.5 -9.8	-53.2 -8.8	-54.6 -8.0	-55.1 -7.2	-55.1 -6.6	-54.5 -6.2	-52.9 -6.0	-50.3 -6.0	-46.3 -6.1	-40.9 -6.2	-34.0 -5.8	-25.9 -4.7	-50
-55	-54.8 -10.4	-57.2 -9.7	-59.2 -9.1	-60.8 -8.5	-62.0 -8.1	-62.7 -7.9	-62.6 -8.0	-61.8 -8.3	-59.8 -9.0	-56.4 -9.8	-51.0 -10.6	-43.3 -10.7	-55
-60	-57.8 -10.1	-60.8 -9.7	-63.6 -9.4	-66.2 -9.1	-68.4 -8.9	-70.4 -8.9	-72.1 -9.1	-73.2 -9.7	-73.8 -10.6	-73.6 -12.1	-72.2 -14.3	-69.0 -17.3	-60
-65	-60.7 -9.0	-64.3 -8.9	-67.7 -8.8	-71.1 -8.7	-74.4 -8.8	-77.6 -8.9	-80.7 -9.2	-83.7 -9.8	-86.7 -10.7	-89.5 -12.0	-92.4 -14.0	-95.2 -17.1	-65
-70	-63.8 -7.4	-67.9 -7.5	-71.9 -7.7	-76.0 -7.8	-80.1 -7.9	-84.2 -8.1	-88.5 -8.4	-92.8 -8.8	-97.4 -9.4	-102.2 -10.2	-107.4 -11.2	-113.2 -12.5	-70
-75	-67.5 -5.7	-71.8 -5.9	-76.5 -6.1	-81.1 -6.3	-85.7 -6.5	-90.6 -6.7	-95.5 -6.9	-100.7 -7.2	-106.0 -7.4	-111.7 -7.7	-117.8 -8.0	-124.3 -8.2	-75
-80	-72.3 -4.0	-77.1 -4.2	-81.9 -4.4	-86.9 -4.5	-91.9 -4.7	-97.1 -4.8	-102.4 -4.9	-107.8 -5.0	-113.5 -5.1	-119.3 -5.1	-125.3 -5.0	131.6 -5.0	-80
-85	-78.8 -2.3	-83.8 -2.4	-88.8 -2.5	-93.9 -2.6	-99.1 -2.6	-104.3 -2.6	-109.6 -2.7	-115.0 -2.6	-120.4 -2.6	-126.0 -2.8	-131.6 -2.5	-137.2 -2.4	-85
-90	-87.3 -.5	-92.3 -.5	-97.3 -.5	-102.3 -.5	-107.3 -.5	-112.3 -.5	-117.3 -.5	-122.3 -.5	-127.3 -.5	-132.3 -.5	-137.3 -.5	-1 2.3 -.5	-90
LAT / E. LONG	60	65	70	75	80	85	90	95	100	105	110	115	LAT / E. LONG

DECLINATION (D) WMM-90

E. LONG / LAT	120	125	130	135	140	145	150	155	160	165	170	175	E. LONG / LAT
0	1.2 / -1.8	1.5 / -1.7	2.0 / -1.3	2.8 / -.9	3.7 / .0	4.8 / .8	5.9 / 1.4	7.1 / 1.7	8.3 / 1.6	9.3 / 1.2	10.1 / .3	10.5 / -.7	0
-5	1.6 / -1.3	2.1 / -1.2	2.7 / -1.0	3.5 / -.5	4.4 / .0	5.5 / .6	6.6 / 1.1	7.8 / 1.4	8.9 / 1.3	9.8 / 1.0	10.5 / .4	10.9 / -.4	-5
-10	1.8 / -.7	2.5 / -.7	3.2 / -.6	4.1 / -.3	5.1 / .0	6.2 / .4	7.3 / .7	8.4 / .9	9.4 / .9	10.4 / .8	11.0 / .4	11.5 / -.1	-10
-15	1.8 / .0	2.7 / -.1	3.6 / -.1	4.6 / .0	5.6 / .1	6.8 / .2	8.0 / .3	9.1 / .5	10.2 / .6	11.1 / .6	11.8 / .5	12.2 / .4	-15
-20	1.6 / .6	2.7 / .5	3.8 / .4	5.0 / .3	6.2 / .2	7.5 / .1	8.8 / .1	10.0 / .2	11.1 / .4	12.0 / .6	12.8 / .8	13.3 / .9	-20
-25	1.0 / 1.1	2.5 / 1.0	4.0 / .8	5.4 / .6	6.9 / .4	8.3 / .2	9.7 / .1	11.1 / .2	12.3 / .4	13.3 / .8	14.1 / 1.1	14.6 / 1.4	-25
-30	-.1 / 1.4	2.1 / 1.4	4.0 / 1.2	5.8 / 1.0	7.6 / .7	9.3 / .5	11.0 / .4	12.5 / .5	13.8 / .8	14.9 / 1.2	15.7 / 1.6	16.3 / 1.9	-30
-35	-1.8 / 1.3	1.2 / 1.5	3.8 / 1.5	6.2 / 1.4	8.5 / 1.3	10.6 / 1.1	12.5 / 1.1	14.2 / 1.2	15.7 / 1.4	16.9 / 1.7	17.8 / 2.0	18.4 / 2.2	-35
-40	-4.6 / .8	-.4 / 1.3	3.3 / 1.7	6.6 / 1.9	9.5 / 2.0	12.2 / 2.1	14.5 / 2.1	16.5 / 2.2	18.1 / 2.3	19.4 / 2.5	20.3 / 2.5	21.0 / 2.4	-40
-45	-9.1 / -.3	-3.2 / .8	2.1 / 1.9	6.7 / 2.6	10.7 / 3.1	14.2 / 3.4	17.0 / 3.5	19.4 / 3.5	21.2 / 3.5	22.6 / 3.3	23.6 / 3.0	24.2 / 2.5	-45
-50	-17.2 / -2.8	-8.6 / -.5	-.6 / 1.8	6.4 / 3.6	12.2 / 4.8	16.9 / 5.4	20.5 / 5.5	23.3 / 5.3	25.6 / 4.9	26.9 / 4.3	27.9 / 3.6	28.4 / 2.7	-50
-55	-32.9 / -9.1	-20.3 / -5.1	-7.2 / .3	4.6 / 5.1	14.0 / 7.9	21.0 / 8.9	26.0 / 8.8	29.4 / 8.1	31.7 / 7.1	33.2 / 5.9	34.1 / 4.7	34.5 / 3.5	-55
-60	-62.5 / -20.7	-50.5 / -22.4	-29.9 / -14.7	-3.7 / 5.2	17.4 / 17.4	30.0 / 18.7	37.0 / 16.5	40.8 / 13.7	42.8 / 11.1	43.8 / 8.9	44.1 / 6.9	44.0 / 5.3	-60
-65	-98.0 / -21.8	-100.9 / -30.0	-104.3 / -47.2	-110.3 / -105.2	98.8 / 350.3	76.2 / 71.4	72.0 / 38.3	69.2 / 25.6	66.8 / 18.7	64.6 / 14.3	62.6 / 11.3	60.7 / 9.2	-65
-70	-120.0 / -14.0	-128.1 / -15.6	-138.4 / -18.8	-152.0 / -18.4	-170.2 / -11.6	167.5 / -1.0	145.0 / 10.2	126.4 / 15.8	112.6 / 16.6	102.4 / 15.5	94.7 / 13.9	88.6 / 12.4	-70
-75	-131.3 / -8.4	-139.1 / -8.3	-147.6 / -7.9	-157.1 / -7.1	-167.4 / -5.6	-178.4 / -3.5	170.1 / -.9	158.6 / 1.8	147.6 / 4.2	137.3 / 6.1	128.0 / 7.4	119.8 / 8.2	-75
-80	-136.0 / -4.8	-144.8 / -4.5	-151.8 / -4.1	-159.1 / -3.6	-166.5 / -3.0	-174.2 / -2.3	178.1 / -1.4	170.3 / -.5	162.6 / .4	155.0 / 1.3	147.5 / 2.1	140.4 / 2.9	-80
-85	-143.0 / -2.3	-148.8 / -2.1	-154.7 / -1.9	-160.6 / -1.7	-166.6 / -1.5	-172.6 / -1.3	-178.6 / -1.0	175.4 / -.7	169.4 / -.5	163.4 / [illegible]	157.4 / .1	151.5 / .3	-85
-90	-147.3 / -.5	-152.3 / -.5	-157.3 / -.5	-162.3 / -.5	-167.3 / -.5	-172.3 / -.5	-177.3 / -.5	177.7 / -.5	172.7 / -.5	167.7 / -.5	162.7 / -.5	157.7 / -.5	-90
LAT / E. LONG	120	125	130	135	140	145	150	155	160	165	170	175	LAT / E. LONG

DECLINATION (D) WMM-90

E. LONG / LAT	180	185	190	195	200	205	210	215	220	225	230	235	E. LONG / LAT
0	10.6 -1.8	10.4 -3.0	10.1 -3.4	9.7 -3.6	9.4 -3.2	9.2 -2.2	9.2 -.8	9.2 .9	9.1 2.7	9.1 4.2	9.0 5.2	8.9 5.5	0
-5	11.0 -1.3	10.9 -2.1	10.5 -2.6	10.2 -2.7	9.9 -2.3	9.7 -1.4	9.7 .0	9.7 1.6	9.6 3.2	9.5 4.6	9.4 5.3	9.4 5.7	-5
-10	11.6 -.6	11.4 -1.1	11.2 -1.5	10.9 -1.6	10.7 -1.2	10.6 -.4	10.5 .7	10.5 2.1	10.5 3.5	10.4 4.7	10.3 5.3	10.2 5.4	-10
-15	12.4 .1	12.4 -.2	12.2 -.4	12.0 -.4	11.8 -.1	11.7 .4	11.7 1.3	11.7 2.4	11.6 3.4	11.5 4.3	11.4 4.7	11.3 4.6	-15
-20	13.5 .9	13.6 .8	13.5 .7	13.3 .6	13.2 .7	13.1 1.0	13.1 1.6	13.0 2.2	13.0 3.0	12.9 3.5	12.8 3.7	12.7 3.5	-20
-25	15.0 1.5	15.1 1.5	15.0 1.4	15.0 1.3	14.8 1.2	14.8 1.2	14.7 1.4	14.6 1.7	14.6 2.1	14.5 2.4	14.5 2.6	14.4 2.4	-25
-30	16.7 2.0	16.9 1.9	16.9 1.7	16.8 1.4	16.7 1.1	16.6 .9	16.5 .8	16.5 .9	16.4 1.1	16.4 1.3	16.4 1.5	16.4 1.4	-30
-35	18.8 2.2	19.0 2.0	19.1 1.6	19.0 1.1	18.9 .5	18.7 .1	18.6 -.1	18.6 -.1	18.6 .1	18.6 .4	18.7 .7	18.9 .9	-35
-40	21.4 2.1	21.6 1.7	21.6 1.0	21.5 .4	21.4 -.3	21.2 -.7	21.1 -.9	21.1 -.8	21.1 -.5	21.3 .0	21.5 .5	21.8 1.1	-40
-45	24.6 1.9	24.7 1.2	24.7 .4	24.6 -.3	24.4 -.9	24.3 -1.3	24.2 -1.3	24.2 -1.0	24.4 -.4	24.6 .3	24.9 1.2	25.2 1.9	-45
-50	28.7 1.8	28.8 .9	28.7 .1	28.6 -.6	28.4 -1.0	28.3 -1.1	28.2 -.9	28.3 -.3	28.5 .5	28.7 1.5	29.0 2.5	29.3 3.4	-50
-55	34.6 2.3	34.5 1.3	34.3 .6	34.1 .1	33.9 -.1	33.7 .1	33.6 .6	33.6 1.4	33.7 2.4	33.9 3.4	34.0 4.4	34.0 5.2	-55
-60	43.7 4.0	43.2 3.1	42.7 2.4	42.2 2.1	41.8 2.2	41.4 2.6	41.1 3.2	40.8 4.0	40.6 4.9	40.4 5.7	40.0 6.4	39.6 6.8	-60
-65	59.0 7.7	57.4 6.6	56.0 6.0	54.7 5.8	53.5 5.8	52.4 6.0	51.4 6.4	50.5 6.9	49.5 7.3	48.6 7.7	47.5 7.8	46.3 7.8	-65
-70	83.7 11.2	79.6 10.3	76.4 9.7	72.9 9.2	70.2 9.0	67.6 8.8	65.3 8.8	63.1 8.7	61.0 8.6	58.8 8.4	56.7 8.1	54.5 7.7	-70
-75	112.5 8.6	106.0 8.8	100.2 8.8	95.0 8.8	90.3 8.6	86.0 8.4	81.9 8.2	78.2 7.9	74.6 7.6	71.1 7.3	67.7 6.9	64.4 6.4	-75
-80	133.5 3.5	126.9 4.0	120.7 4.4	114.7 4.7	109.1 4.8	103.7 4.9	98.6 4.9	93.7 4.9	88.9 4.8	84.4 4.6	80.0 4.4	75.6 4.1	-80
-85	145.7 .6	139.9 .8	134.3 1.0	128.7 1.2	123.2 1.3	117.8 1.4	112.4 1.5	107.2 1.6	102.1 1.6	97.1 1.7	92.1 1.7	87.2 1.6	-85
-90	152.7 -.5	147.7 -.5	142.7 -.5	137.7 -.5	132.7 -.5	127.7 -.5	122.7 -.5	117.7 -.5	112.7 -.5	107.7 -.5	102.7 -.5	97.7 -.5	-90
LAT / E. LONG	180	185	190	195	200	205	210	215	220	225	230	235	LAT / E. LONG

DECLINATION (D) WMM-90

E. LONG / LAT	240	245	250	255	260	265	270	275	280	285	290	295	LAT / E. LONG
0	8.9 5.1	9.0 3.9	9.0 2.1	8.9 -.1	8.6 -2.6	7.8 -5.0	6.1 -7.3	4.0 -8.2	1.3 -10.6	-1.9 -11.3	-5.4 -11.3	-9.0 -10.5	0
-5	9.4 5.1	9.6 3.8	9.5 1.8	9.4 -.5	9.0 -2.9	8.3 -5.3	6.9 -7.5	5.0 -9.2	2.3 -10.5	-.8 -11.2	-4.4 -11.3	-8.2 -10.8	-5
-10	10.1 4.6	10.1 3.2	10.2 1.3	10.1 -1.0	9.8 -3.4	9.1 -5.6	7.9 -7.6	6.1 -9.1	3.5 -10.3	.3 -11.0	-3.4 -11.2	-7.3 -10.9	-10
-15	11.2 3.8	11.2 2.4	11.2 .6	11.1 -1.5	10.8 -3.7	10.2 -5.7	9.1 -7.5	7.3 -8.9	4.8 -9.9	1.7 -10.6	-2.1 -10.9	-6.1 -10.7	-15
-20	12.6 2.8	12.6 1.6	12.5 -.1	12.5 -1.9	12.2 -3.8	11.7 -5.5	10.6 -7.1	8.9 -8.3	6.5 -9.3	3.3 -10.0	-.5 -10.4	-4.7 -10.4	-20
-25	14.4 1.8	14.4 .8	14.3 -.5	14.3 -1.9	14.1 -3.5	13.5 -4.9	12.5 -6.3	10.8 -7.4	8.4 -8.3	5.2 -9.1	1.3 -9.6	-3.0 -9.8	-25
-30	16.5 1.1	16.6 .5	16.6 -.4	16.6 -1.5	16.3 -2.7	15.8 -3.9	14.7 -5.0	13.0 -6.1	10.5 -7.1	7.3 -7.9	3.5 -8.6	-.9 -8.9	-30
-35	19.0 .9	19.2 .7	19.3 .2	19.3 -.5	19.0 -1.3	18.3 -2.3	17.2 -3.4	15.4 -4.4	12.9 -5.5	9.7 -6.4	5.8 -7.3	1.5 -7.8	-35
-40	22.1 1.4	22.3 1.5	22.4 1.4	22.3 1.0	21.9 .3	21.1 -.5	19.8 -1.5	17.8 -2.6	15.3 -3.8	12.1 -4.8	8.3 -5.7	4.0 -6.3	-40
-45	25.5 2.5	25.7 2.9	25.7 2.9	25.4 2.6	24.8 2.0	23.8 1.2	22.3 .2	20.2 -1.0	17.6 -2.1	14.4 -3.3	10.7 -4.2	6.7 -4.7	-45
-50	29.5 4.1	29.5 4.5	29.2 4.5	28.7 4.1	27.8 3.5	26.5 2.6	24.7 1.5	22.5 .3	19.8 -.8	16.6 -1.9	13.1 -2.7	9.3 -3.2	-50
-55	33.9 5.7	33.5 5.9	32.9 5.7	32.0 5.2	30.7 4.5	29.1 3.5	27.1 2.4	24.7 1.2	21.9 .1	18.8 -.8	15.4 -1.5	11.9 -1.9	-55
-60	39.0 7.0	38.1 6.8	37.0 6.4	35.6 5.7	33.8 4.9	31.8 3.9	29.6 2.8	27.0 1.8	24.1 .8	21.1 .0	17.8 -.5	14.5 -.8	-60
-65	45.8 7.5	43.4 7.1	41.7 6.5	39.7 5.7	37.5 4.8	35.1 3.9	32.5 3.0	29.7 2.1	26.8 1.3	23.7 .7	20.5 .3	17.3 .1	-65
-70	52.2 7.2	49.9 6.6	47.4 5.9	44.8 5.2	42.1 4.4	39.2 3.6	36.3 2.9	33.2 2.2	30.1 1.7	26.9 1.2	23.7 .9	20.5 .7	-70
-75	61.1 5.9	57.8 5.4	54.5 4.8	51.2 4.2	47.9 3.7	44.5 3.1	41.2 2.6	37.8 2.2	34.3 1.8	30.9 1.5	27.5 1.3	24.1 1.1	-75
-80	71.4 3.9	67.3 3.6	63.2 3.3	59.2 3.0	55.2 2.7	51.1 2.4	47.4 2.1	43.5 1.9	39.6 1.6	35.8 1.5	32.0 1.3	28.2 1.2	-80
-85	82.4 1.6	77.6 1.5	73.0 1.5	68.3 1.4	63.8 1.3	59.2 1.2	54.7 1.1	50.3 1.0	45.9 .9	41.5 .8	37.1 .7	32.8 .7	-85
-90	92.7 -.5	87.7 -.5	82.7 -.5	77.7 -.5	72.7 -.5	67.7 -.5	62.7 -.5	57.7 -.5	52.7 -.5	47.7 -.5	42.7 -.5	37.7 -.5	-90
LAT / E. LONG	240	245	250	255	260	265	270	275	280	285	290	295	LAT / E. LONG

DECLINATION (D) WMM-90

E. LONG	300	305	310	315	320	325	330	335	340	345	350	355	E. LONG
LAT													LAT
0	-12.4 -9.2	-15.5 -7.3	-18.0 -5.2	-19.7 -3.0	-20.7 -.8	-20.8 1.3	-20.2 3.2	-18.8 4.9	-17.0 6.3	-14.8 7.3	-12.6 7.9	-10.5 8.1	0
-5	-11.8 -9.7	-15.2 -8.2	-16.0 -6.3	-20.1 -4.3	-21.4 -2.1	-21.9 .0	-21.6 2.1	-20.7 4.0	-19.1 5.6	-17.2 7.0	-15.1 7.9	-13.0 9.4	-5
-10	-11.1 -10.1	-14.7 -8.9	-17.6 -7.2	-20.3 -5.3	-21.9 -3.3	-22.8 -1.5	-23.0 .8	-22.4 2.8	-21.3 4.7	-19.7 6.3	-17.9 7.6	-15.9 8.5	-10
-15	-10.2 -10.1	-14.1 -9.1	-17.5 -7.8	-20.2 -6.5	-22.2 -4.4	-23.5 -2.4	-24.0 -.4	-23.9 1.6	-23.3 3.5	-22.2 5.3	-20.7 6.8	-19.0 8.0	-15
-20	-9.0 -10.0	-13.1 -9.2	-16.8 -8.1	-19.8 -6.7	-22.1 -5.0	-23.8 -3.2	-24.7 -1.4	-25.0 .5	-24.8 2.3	-24.2 4.0	-23.3 5.5	-22.0 6.8	-20
-25	-7.5 -9.6	-11.8 -9.0	-15.7 -8.0	-19.0 -6.7	-21.6 -5.2	-23.6 -3.6	-24.8 -1.9	-25.5 -.2	-25.8 1.4	-25.6 2.9	-25.1 4.2	-24.3 5.3	-25
-30	-5.5 -8.9	-10.0 -8.5	-14.1 -7.6	-17.3 -6.5	-20.6 -4.8	-22.8 -3.2	-24.3 -1.6	-25.3 -.1	-25.9 1.3	-26.1 2.5	-26.0 3.4	-25.6 4.0	-30
-35	-3.1 -7.9	-7.7 -7.5	-12.0 -6.6	-15.7 -5.4	-18.8 -3.8	-21.2 -2.2	-23.0 -.5	-24.2 1.0	-25.1 2.3	-25.6 3.2	-25.8 3.7	-25.7 3.7	-35
-40	-.5 -6.5	-4.9 -6.1	-9.2 -5.2	-12.9 -3.9	-16.1 -2.2	-18.7 -.4	-20.7 1.4	-22.1 3.0	-23.2 4.2	-23.9 4.9	-24.3 4.9	-24.6 4.2	-40
-45	2.4 -4.9	-1.8 -4.5	-5.9 -3.5	-9.5 -2.2	-12.7 -.4	-15.3 1.5	-17.4 3.4	-19.0 5.0	-20.3 6.2	-21.2 6.7	-22.0 6.3	-22.8 5.0	-45
-50	5.4 -3.3	1.4 -2.8	-2.3 -1.9	-5.7 -.5	-8.8 1.2	-11.4 3.0	-13.6 4.8	-15.4 6.3	-16.9 7.3	-18.2 7.5	-19.4 6.9	-20.6 5.3	-50
-55	6.3 -1.9	4.7 -1.4	1.2 -.6	-2.0 .6	-4.9 2.1	-7.5 3.7	-9.7 5.2	-11.7 6.4	-13.5 7.1	-15.2 7.1	-16.9 6.3	-18.7 4.8	-55
-60	11.1 -.8	7.9 -.4	4.6 .3	1.4 1.[illegible]	-1.2 2.4	-3.9 3.6	-6.3 4.7	-8.6 5.5	-10.7 5.9	-12.8 5.8	-14.9 5.1	-17.2 3.8	-60
-65	14.1 .1	10.9 .4	7.8 .9	4.8 1.5	2.0 2.2	-.8 3.0	-3.4 3.6	-6.0 4.1	-8.5 4.3	-11.0 4.1	-13.6 3.8	-16.2 2.7	-65
-70	17.2 .7	14.0 .9	10.9 1.1	7.8 1.4	4.8 1.8	1.8 2.2	-1.1 2.5	-4.0 2.7	-6.9 2.7	-9.8 2.5	-12.8 2.1	-15.8 1.6	-70
-75	20.7 1.1	17.3 1.1	13.9 1.1	10.6 1.2	7.3 1.3	4.0 1.4	.7 1.5	-2.6 1.5	-5.9 1.4	-9.2 1.2	-12.6 1.0	-16.0 .6	-75
-80	24.4 1.0	20.7 1.0	16.9 .9	13.2 .8	9.5 .8	5.7 .7	2.0 .7	-1.7 .6	-5.5 .4	-9.3 .3	-13.1 .1	-17.0 -.1	-80
-85	28.5 .6	24.2 .5	19.9 .4	15.6 .3	11.3 .2	7.0 .1	2.7 .0	-1.6 -.1	-5.9 -.2	-10.2 -.3	-14.5 -.4	-18.9 -.6	-85
-90	32.7 -.5	27.7 -.5	22.7 -.5	17.7 -.5	12.7 -.5	7.7 -.5	2.7 -.5	-2.3 -.5	-7.3 -.5	-12.3 -.5	-17.3 -.5	-22.3 -.5	-90
LAT													LAT
E. LONG	300	305	310	315	320	325	330	335	340	345	350	355	E. LONG

INCLINATION (I) WMM-90

E. LONG / LAT	0	5	10	15	20	25	30	35	40	45	50	55	LAT / E. LONG
90	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	90
85	85.2 1.0	85.2 1.0	85.2 1.0	85.2 1.0	85.3 1.0	85.3 1.0	85.4 1.0	85.5 1.0	85.6 1.0	85.7 1.1	85.9 1.1	86.0 1.0	85
80	82.7 1.1	82.7 1.1	82.7 1.2	82.7 1.2	82.8 1.2	82.9 1.2	83.0 1.2	83.2 1.3	83.4 1.3	83.6 1.3	83.9 1.3	84.2 1.3	80
75	80.3 1.1	80.3 1.1	80.3 1.2	80.3 1.2	80.4 1.3	80.5 1.3	80.7 1.3	80.9 1.3	81.1 1.3	81.4 1.3	81.7 1.3	82.1 1.4	75
70	77.9 .9	77.9 1.0	77.9 1.1	77.9 1.1	78.0 1.2	78.2 1.2	78.3 1.2	78.5 1.3	78.8 1.3	79.1 1.3	79.5 1.3	79.9 1.3	70
65	75.4 .7	75.4 .9	75.4 1.0	75.4 1.0	75.5 1.1	75.7 1.1	75.9 1.1	76.1 1.1	76.3 1.1	76.6 1.1	76.9 1.1	77.3 1.1	65
60	72.5 .5	72.5 .7	72.5 .9	72.6 1.0	72.8 1.0	72.9 1.1	73.1 1.1	73.3 1.1	73.6 1.0	73.8 1.0	74.2 1.0	74.5 .9	60
55	69.1 .3	69.2 .6	69.3 .8	69.4 1.0	69.6 1.1	69.8 1.1	70.0 1.1	70.2 1.1	70.5 1.0	70.7 .9	71.0 .8	71.3 .7	55
50	65.2 .1	65.3 .5	65.5 .8	65.7 1.0	65.9 1.2	66.2 1.3	66.4 1.3	66.7 1.2	66.9 1.1	67.2 .9	67.4 .7	67.7 .6	50
45	60.5 -.2	60.7 .3	60.9 .8	61.2 1.1	61.5 1.4	61.9 1.5	62.2 1.5	62.5 1.4	62.7 1.2	63.0 1.0	63.3 .7	63.5 .5	45
40	55.1 -.6	55.3 .1	55.6 .7	55.9 1.2	56.3 1.5	56.7 1.7	57.0 1.7	57.4 1.5	57.7 1.3	58.1 1.0	58.3 .7	58.5 .5	40
35	48.5 -1.1	48.8 -.2	49.1 .5	49.5 1.1	50.0 1.5	50.4 1.7	50.8 1.8	51.3 1.6	51.7 1.4	52.2 1.1	52.5 .8	52.7 .6	35
30	40.8 -1.7	41.0 -.6	41.4 .3	41.9 1.0	42.4 1.5	42.8 1.7	43.4 1.8	43.9 1.7	44.5 1.4	45.1 1.2	45.5 .9	45.8 .7	30
25	31.6 -2.4	31.9 -1.2	32.3 -.1	32.8 .7	33.3 1.3	33.9 1.6	34.5 1.7	35.2 1.6	36.0 1.5	36.7 1.3	37.3 1.1	37.6 1.1	25
20	21.0 -3.3	21.3 -1.9	21.8 -.6	22.3 .3	22.8 1.0	23.4 1.4	24.2 1.5	25.1 1.5	26.0 1.5	27.0 1.5	27.7 1.5	28.2 1.5	20
15	9.2 -4.2	9.5 -2.6	9.9 -1.2	10.4 -.2	10.9 .6	11.6 1.1	12.5 1.3	13.6 1.5	14.8 1.6	16.0 1.7	16.9 1.9	17.4 2.1	15
10	-3.3 -5.1	-3.2 -3.3	-2.8 -1.9	-2.4 -.7	-1.8 .1	-1.1 .7	-.1 1.2	1.2 1.5	2.6 1.8	4.0 2.1	5.0 2.4	5.7 2.7	10
5	-15.7 -6.0	-15.8 -4.1	-15.6 -2.6	-15.3 -1.4	-14.8 -.4	-14.0 .4	-12.9 1.1	-11.5 1.6	-9.9 2.1	-8.4 2.6	-7.2 3.0	-6.6 3.2	5
0	-27.3 -6.8	-27.7 -5.0	-27.8 -3.4	-27.6 -2.0	-27.2 -.9	-26.4 .1	-25.2 1.0	-23.8 1.8	-22.1 2.5	-20.5 3.1	-19.3 3.5	-18.6 3.7	0
LAT / E. LONG	0	5	10	15	20	25	30	35	40	45	50	55	LAT / E. LONG

Deg.
(units : min/yr)

INCLINATION (I) WMM-90

E. LONG / LAT	60	65	70	75	80	85	90	95	100	105	110	115	E. LONG / LAT
90	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	90
85	86.2 1.0	86.4 1.0	86.6 1.0	86.8 1.0	87.0 1.0	87.2 1.0	87.4 1.0	87.6 1.0	87.8 1.0	87.9 1.0	88.1 .9	88.2 .9	85
80	84.5 1.3	84.8 1.3	85.2 1.3	85.5 1.2	85.9 1.2	86.3 1.2	86.6 1.2	86.9 1.2	87.2 1.2	87.4 1.1	87.5 1.0	87.5 .9	80
75	82.5 1.4	83.0 1.4	83.4 1.4	83.9 1.4	84.4 1.4	84.8 1.4	85.3 1.4	85.6 1.3	85.8 1.3	85.9 1.2	85.9 1.1	85.7 1.0	75
70	80.3 1.3	80.8 1.3	81.3 1.4	81.8 1.4	82.3 1.4	82.8 1.4	83.3 1.4	83.6 1.4	83.8 1.4	83.7 1.3	83.6 1.3	83.2 1.2	70
65	77.8 1.1	78.2 1.2	78.7 1.2	79.3 1.2	79.8 1.3	80.2 1.3	80.6 1.4	80.9 1.4	81.0 1.4	80.9 1.4	80.7 1.4	80.2 1.4	65
60	74.9 .9	75.3 .9	75.8 .9	76.2 1.0	76.7 1.1	77.1 1.2	77.4 1.2	77.6 1.3	77.7 1.4	77.6 1.5	77.3 1.5	76.8 1.5	60
55	71.7 .6	72.0 .6	72.4 .6	72.8 .7	73.1 .8	73.4 .9	73.7 1.0	73.9 1.2	73.9 1.3	73.7 1.4	73.4 1.5	72.9 1.6	55
50	68.0 .4	68.2 .4	68.5 .3	68.8 .4	69.0 .5	69.3 .7	69.4 .8	69.5 1.0	69.5 1.2	69.4 1.4	69.0 1.5	68.5 1.6	50
45	63.7 .3	63.8 .2	64.0 .1	64.2 .2	64.3 .3	64.5 .5	64.6 .7	64.6 1.0	64.6 1.2	64.4 1.4	64.1 1.6	63.6 1.7	45
40	58.7 .3	58.8 .1	58.8 .1	58.9 .2	58.9 .3	58.9 .6	59.0 .8	59.0 1.1	58.9 1.4	58.8 1.6	58.5 1.7	58.0 1.8	40
35	52.8 .4	52.8 .3	52.7 .3	52.7 .4	52.6 .6	52.5 .8	52.5 1.2	52.4 1.5	52.4 1.7	52.3 1.9	52.0 2.0	51.7 2.0	35
30	45.9 .6	45.8 .6	45.6 .7	45.4 .8	45.2 1.1	45.1 1.4	44.9 1.7	44.8 2.0	44.8 2.3	44.7 2.4	44.6 2.4	44.3 2.2	30
25	37.7 1.1	37.6 1.1	37.3 1.3	37.0 1.5	36.7 1.8	36.4 2.1	36.2 2.5	36.1 2.8	36.1 3.0	36.1 3.0	36.0 2.9	35.9 2.5	25
20	28.2 1.6	28.1 1.8	27.7 2.0	27.3 2.3	26.8 2.6	26.5 2.9	26.2 3.3	26.1 3.6	26.1 3.7	26.2 3.6	26.3 3.3	26.2 2.8	20
15	17.5 2.3	17.3 2.5	16.9 2.7	16.3 3.0	15.8 3.4	15.3 3.7	15.0 4.0	14.9 4.2	15.0 4.3	15.2 4.1	15.4 3.6	15.5 2.6	15
10	5.8 2.9	5.6 3.1	5.1 3.4	4.5 3.6	3.9 3.9	3.4 4.2	3.0 4.4	3.0 4.5	3.1 4.5	3.4 4.2	3.6 3.6	4.1 2.8	10
5	-6.4 3.4	-6.6 3.6	-7.1 3.7	-7.8 3.9	-8.4 4.0	-8.9 4.2	-9.1 4.3	-9.2 4.4	-8.9 4.3	-8.5 3.9	-7.9 3.3	-7.5 2.4	5
0	-18.4 3.7	-18.6 3.7	-19.0 3.7	-19.6 3.7	-20.2 3.7	-20.6 3.8	-20.9 3.6	-20.8 3.8	-20.5 3.6	-19.9 3.2	-19.3 2.6	-18.7 1.8	0
LAT / E. LONG	60	65	70	75	80	85	90	95	100	105	110	115	LAT / E. LONG

INCLINATION (I) WMM-90

E. LONG LAT	120	125	130	135	140	145	150	155	160	165	170	175	E. LONG LAT
90	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	90
85	88.4 .9	88.4 .9	88.5 .8	88.5 .8	88.5 .7	88.5 .7	88.5 .7	88.4 .6	88.4 .6	88.4 .6	88.4 .6	88.4 .6	85
80	87.6 .8	87.2 .7	87.0 .7	86.7 .6	86.5 .6	86.2 .6	86.0 .6	85.8 .7	85.6 .7	85.5 .7	85.4 .7	85.4 .7	80
75	85.3 .9	84.9 .9	84.5 .8	84.0 .8	83.6 .9	83.1 .9	82.8 .9	82.4 1.0	82.2 1.0	82.0 1.1	81.8 1.1	81.8 1.1	75
70	82.7 1.1	82.2 1.1	81.5 1.1	80.9 1.1	80.3 1.1	79.7 1.2	79.2 1.2	78.7 1.3	78.4 1.3	78.1 1.4	77.9 1.4	77.9 1.4	70
65	79.6 1.3	78.9 1.3	78.2 1.3	77.4 1.3	76.6 1.3	75.9 1.3	75.3 1.4	74.8 1.4	74.3 1.4	74.0 1.4	73.8 1.5	73.6 1.5	65
60	76.1 1.5	75.3 1.5	74.5 1.5	73.6 1.4	72.7 1.4	71.9 1.4	71.2 1.4	70.6 1.4	70.1 1.3	69.8 1.3	69.6 1.3	69.6 1.3	60
55	72.2 1.6	71.6 1.6	70.5 1.6	69.5 1.5	68.6 1.5	67.7 1.4	66.9 1.3	66.3 1.2	65.8 1.1	65.5 1.0	65.3 .9	65.4 .8	55
50	67.6 1.6	67.0 1.6	66.0 1.6	65.1 1.5	64.1 1.4	63.2 1.3	62.4 1.2	61.8 1.0	61.3 .8	61.0 .6	61.0 .4	61.1 .1	50
45	62.9 1.7	62.1 1.7	61.2 1.6	60.2 1.5	59.2 1.4	58.3 1.2	57.5 1.1	56.9 .8	56.6 .6	56.4 .3	56.5 .0	56.7 -.3	45
40	57.4 1.8	56.6 1.7	55.7 1.6	54.7 1.5	53.8 1.3	52.9 1.2	52.2 1.0	51.7 .8	51.5 .5	51.5 .2	51.7 -.2	52.2 -.5	40
35	51.1 1.8	50.4 1.7	49.5 1.5	48.6 1.4	47.7 1.2	46.9 1.1	46.3 1.0	46.0 .9	45.9 .7	46.2 .4	46.7 .1	47.4 -.2	35
30	43.9 2.0	43.2 1.6	42.4 1.3	41.5 1.1	40.7 1.0	40.1 1.0	39.7 1.0	39.5 1.1	39.7 1.2	40.3 1.1	41.1 .9	42.2 .6	30
25	35.5 2.1	34.9 1.5	34.2 1.1	33.5 .7	32.8 .8	32.4 .7	32.2 1.0	32.3 1.5	32.8 1.8	33.7 2.1	34.9 2.1	36.4 1.9	25
20	26.0 2.1	25.6 1.5	25.0 .7	24.4 .5	23.9 .1	23.7 .4	23.7 1.0	24.2 1.7	25.0 2.5	26.2 3.1	27.8 3.4	29.7 3.5	20
15	15.5 2.0	15.2 1.1	14.8 .2	14.4 -.3	14.1 -.4	14.1 -.1	14.5 .7	15.2 1.6	16.3 3.0	17.8 4.0	19.8 4.5	21.9 4.5	15
10	4.2 1.7	4.1 .7	3.9 -.3	3.7 -.9	3.7 -1.0	3.8 -.6	4.5 .4	5.5 1.7	6.9 3.1	8.7 4.3	10.9 5.1	13.2 5.2	10
5	-7.2 1.3	-7.1 .3	-7.2 -.7	-7.1 -1.1	-6.9 -1.4	-6.5 -1.0	-5.7 -.1	-4.5 1.4	-3.0 2.7	-1.8 4.0	1.3 4.6	3.5 5.1	5
0	-19.3 .9	-18.0 -.1	-17.9 -.9	-17.6 -1.5	-17.3 -1.6	-16.6 -1.3	-15.7 -.5	-14.5 .7	-13.0 2.0	-11.1 3.2	-8.9 4.0	-6.6 4.3	0
LAT E. LONG	120	125	130	135	140	145	150	155	160	165	170	175	LAT E. LONG

INCLINATION (I) WMM-90

E. LONG / LAT	180	185	190	195	200	205	210	215	220	225	230	235	E. LONG / LAT
90	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	90
85	88.4 .6	88.4 .6	88.5 .6	88.6 .6	88.6 .8	88.7 .6	88.8 .7	88.9 .7	89.0 .7	89.1 .8	89.2 .8	89.2 .8	85
80	85.4 .8	85.4 .8	85.5 .8	85.7 .8	85.9 .8	86.1 .8	86.4 .7	86.7 .7	87.0 .7	87.4 .7	87.8 .6	88.2 .6	80
75	81.8 1.2	81.9 1.2	82.1 1.2	82.3 1.2	82.6 1.2	83.0 1.1	83.4 1.1	83.9 1.0	84.4 1.0	85.0 .9	85.6 .8	86.3 .6	75
70	77.9 1.5	78.1 1.5	78.3 1.5	78.7 1.5	79.1 1.4	79.6 1.4	80.2 1.3	80.9 1.2	81.6 1.1	82.3 1.0	83.2 .8	84.0 .6	70
65	73.9 1.5	74.1 1.5	74.4 1.5	74.8 1.5	75.4 1.5	76.0 1.4	76.8 1.3	77.6 1.2	78.4 1.1	79.4 .9	80.3 .6	81.3 .4	65
60	69.7 1.3	70.0 1.3	70.4 1.3	70.9 1.3	71.5 1.3	72.3 1.2	73.1 1.2	74.0 1.0	75.0 .9	76.1 .6	77.1 .4	78.2 .1	60
55	65.5 .8	65.9 .9	66.3 .8	66.9 .9	67.6 .9	68.5 .9	69.4 .8	70.4 .7	71.4 .6	72.5 .3	73.6 .1	74.7 -.2	55
50	61.3 .2	61.8 .1	62.3 .2	63.0 .2	63.8 .3	64.6 .4	65.6 .4	66.6 .4	67.7 .3	68.8 .1	69.9 -.2	71.0 -.5	50
45	57.1 -.4	57.7 -.5	58.3 -.5	59.1 -.4	59.9 -.2	60.8 -.1	61.7 .0	62.7 .0	63.8 .0	64.9 -.2	66.0 -.4	67.1 -.6	45
40	52.8 -.8	53.6 -.9	54.4 -1.0	55.2 -.9	56.1 -.8	57.0 -.6	57.9 -.4	58.8 -.4	59.8 -.4	60.8 -.4	61.9 -.6	62.9 -.7	40
35	48.3 -.8	49.3 -.9	50.3 -1.1	51.2 -1.2	52.1 -1.2	53.0 -1.1	53.8 -.9	54.7 -.8	55.6 -.8	56.6 -.7	57.6 -.7	58.6 -.7	35
30	43.4 .1	44.7 -.3	45.8 -.8	46.9 -1.2	47.8 -1.4	48.6 -1.5	49.4 -1.5	50.2 -1.4	51.1 -1.3	51.9 -1.2	52.9 -.9	53.8 -.7	30
25	37.9 1.3	39.6 .6	40.8 -.2	41.9 -.9	42.8 -1.6	43.6 -2.0	44.3 -2.2	45.1 -2.2	45.9 -2.1	46.7 -1.7	47.6 -1.3	48.5 -.7	25
20	31.5 2.7	33.3 1.9	34.8 .6	36.0 -.6	36.9 -1.7	37.7 -2.6	38.4 -3.1	39.1 -3.2	39.8 -3.0	40.6 -2.4	41.4 -1.6	42.3 -.6	20
15	24.1 3.9	26.0 2.8	27.6 1.3	28.9 -.4	29.8 -2.0	30.6 -3.3	31.3 -4.1	32.0 -4.3	32.8 -4.0	33.5 -3.1	34.3 -1.9	35.1 -.4	15
10	15.5 4.6	17.5 3.4	19.2 1.7	20.5 -.3	21.5 -2.3	22.3 -3.9	23.1 -4.9	23.8 -5.3	24.6 -4.8	25.4 -3.7	26.2 -2.0	27.0 .1	10
5	5.9 4.6	8.0 3.4	9.7 1.7	11.0 -.4	12.1 -2.5	12.9 -4.3	13.7 -5.5	14.6 -5.8	15.4 -5.2	16.3 -3.8	17.1 -1.7	17.9 .8	5
0	-4.4 3.9	-2.3 2.9	-.6 1.3	.7 -.7	1.8 -2.7	2.7 -4.4	3.6 -5.5	4.6 -5.7	5.5 -5.0	6.4 -3.3	7.3 -1.0	8.2 1.8	0
LAT E. LONG	180	185	190	195	200	205	210	215	220	225	230	235	LAT E. LONG

INCLINATION (I) WMM-90

E. LONG / LAT	240	245	250	255	260	265	270	275	280	285	290	295	E. LONG / LAT
90	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	90
85	89.1 .8	89.0 .7	88.9 .7	88.7 .6	88.5 .6	88.3 .6	88.1 .5	87.9 .6	87.6 .6	87.4 .6	87.1 .6	86.9 .6	85
80	88.7 .6	89.1 .7	89.6 .9	89.7 .8	89.3 .2	88.8 .1	88.3 .1	87.8 .2	87.4 .2	86.9 .2	86.4 .3	86.0 .4	80
75	87.0 .5	87.7 .3	88.4 .0	89.0 -.5	89.6 -1.4	89.0 -1.2	88.4 -.9	87.6 -.6	86.9 -.5	86.2 -.3	85.6 -.2	84.9 -.1	75
70	84.9 .4	85.7 .1	86.5 -.3	87.3 -.8	87.8 -1.3	87.9 -1.7	87.5 -1.7	86.9 -1.5	86.1 -1.3	85.2 -1.1	84.6 -1.0	83.6 -.8	70
65	82.3 .1	83.3 -.2	84.2 -.6	85.0 -1.0	85.6 -1.4	85.8 -1.8	85.7 -2.0	85.2 -2.1	84.5 -2.0	83.7 -1.9	82.8 -1.7	81.8 -1.6	65
60	79.3 -.2	80.3 -.5	81.3 -.9	82.1 -1.2	82.8 -1.5	83.2 -1.9	83.2 -2.1	82.9 -2.3	82.3 -2.4	81.5 -2.4	80.6 -2.4	79.6 -2.5	60
55	75.9 -.5	76.9 -.8	78.0 -1.1	78.9 -1.3	79.6 -1.6	80.0 -1.8	80.2 -2.1	80.0 -2.4	79.6 -2.6	78.8 -2.9	77.9 -3.0	76.9 -3.0	55
50	72.1 -.7	73.2 -.9	74.3 -1.1	75.2 -1.3	76.0 -1.5	76.6 -1.7	76.9 -2.0	76.8 -2.4	76.6 -2.8	75.7 -3.2	74.8 -3.5	73.8 -3.7	50
45	68.2 -.8	69.3 -.9	70.3 -1.0	71.3 -1.1	72.2 -1.3	72.8 -1.5	73.2 -1.8	73.3 -2.3	73.0 -2.9	72.4 -3.5	71.5 -4.0	70.3 -4.4	45
40	64.0 -.8	65.1 -.8	66.2 -.8	67.2 -.8	68.1 -.9	68.8 -1.1	69.3 -1.5	69.4 -2.2	69.3 -2.9	68.7 -3.8	67.8 -4.5	66.7 -5.2	40
35	59.6 -.6	60.7 -.5	61.7 -.4	62.8 -.3	63.7 -.3	64.5 -.6	65.1 -1.1	65.3 -1.9	65.3 -2.9	64.8 -4.0	63.9 -5.0	62.7 -5.9	35
30	54.8 -.4	55.8 .0	56.9 .3	57.9 .5	58.9 .5	59.8 .2	60.5 -.4	60.9 -1.4	60.9 -2.7	60.5 -4.1	59.7 -5.5	58.5 -6.7	30
25	49.4 .0	50.4 .6	51.5 1.2	52.6 1.5	53.7 1.6	54.7 1.2	55.5 .4	56.0 -.8	56.2 -2.3	55.9 -4.1	55.1 -5.8	53.9 -7.5	25
20	43.2 .5	44.2 1.5	45.3 2.3	46.5 2.8	47.7 2.9	48.9 2.5	49.9 1.6	50.7 .1	51.0 -1.7	50.8 -3.9	50.1 -6.1	48.8 -8.1	20
15	36.0 1.2	37.0 2.6	38.2 3.8	39.5 4.5	40.9 4.6	42.4 4.1	43.8 2.9	44.6 1.2	45.2 -1.0	45.2 -3.5	44.6 -6.1	43.2 -8.6	15
10	27.9 2.1	28.9 4.0	30.2 5.5	31.7 6.4	33.3 6.4	35.0 5.8	36.4 4.4	37.9 2.4	38.7 -.1	38.8 -3.0	38.3 -6.0	37.0 -9.0	10
5	18.9 3.3	20.0 5.8	21.3 7.3	23.0 9.2	24.8 8.3	26.8 7.5	28.7 5.8	30.2 4.3	31.3 .7	31.7 -2.5	31.3 -5.8	30.9 -9.2	5
0	9.2 4.6	10.4 7.1	11.8 8.9	13.5 9.8	15.6 9.8	17.7 8.8	19.8 6.9	21.8 4.4	23.3 1.3	23.8 -2.1	23.3 -5.7	22.2 -6.3	0
LAT / E. LONG	240	245	250	255	260	265	270	275	280	285	290	295	LAT / E. LONG

INCLINATION (I) WMM-90

E. LONG LAT	300	305	310	315	320	325	330	335	340	345	350	355	E. LONG LAT
90	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	87.8 .8	90
85	86.7 .6	86.5 .7	86.3 .7	86.1 .7	86.0 .8	85.8 .8	85.7 .8	85.6 .8	85.4 .9	85.4 .9	85.3 .9	85.2 .9	85
80	85.6 .4	85.2 .6	84.8 .5	84.4 .6	84.1 .7	83.8 .7	83.6 .8	83.4 .9	83.2 .9	83.0 1.0	82.9 1.0	82.8 1.1	80
75	84.3 .0	83.7 .1	83.2 .2	82.7 .3	82.3 .4	81.9 .5	81.5 .6	81.2 .7	80.9 .8	80.7 .9	80.6 .9	80.4 1.0	75
70	82.8 -.7	82.1 -.5	81.4 -.4	80.8 -.2	80.2 -.1	79.7 .1	79.3 .2	78.9 .4	78.6 .5	78.4 .6	78.2 .7	78.0 .8	70
65	80.9 -1.4	80.1 -1.3	79.3 -1.1	78.5 -.9	77.9 -.7	77.3 -.5	76.8 -.3	76.4 -.1	76.1 .1	75.8 .3	75.6 .5	75.5 .6	65
60	78.6 -2.2	77.6 -2.1	76.7 -1.9	75.9 -1.6	75.1 -1.4	74.5 -1.1	73.9 -.8	73.5 -.6	73.1 -.3	72.8 -.1	72.6 .1	72.5 .4	60
55	75.8 -3.0	74.7 -2.9	73.7 -2.7	72.8 -2.4	71.9 -2.2	71.2 -1.8	70.6 -1.5	70.1 -1.2	69.7 -.8	69.4 -.5	69.2 -.2	69.1 .1	55
50	72.6 -3.8	71.4 -3.7	70.3 -3.6	69.2 -3.3	68.3 -3.0	67.5 -2.6	66.8 -2.2	66.2 -1.8	65.8 -1.4	65.6 -1.0	65.2 -.6	65.2 -.3	50
45	69.1 -4.6	67.8 -4.7	66.5 -4.6	65.3 -4.3	64.2 -4.0	63.2 -3.6	62.4 -3.1	61.7 -2.7	61.2 -2.2	60.8 -1.7	60.6 -1.2	60.5 -.7	45
40	65.3 -5.6	63.9 -5.8	62.4 -5.7	61.0 -5.5	59.6 -5.2	58.5 -4.8	57.4 -4.3	56.6 -3.7	55.9 -3.1	55.4 -2.5	55.1 -1.9	55.0 -1.2	40
35	61.3 -6.6	59.6 -7.0	57.9 -7.1	56.2 -7.0	54.5 -6.7	53.0 -6.2	51.7 -5.7	50.6 -5.0	49.7 -4.3	49.0 -3.6	48.6 -2.8	48.5 -1.9	35
30	56.9 -7.7	55.0 -8.4	53.0 -8.7	50.9 -8.7	48.9 -8.5	46.8 -8.0	45.2 -7.4	43.6 -6.6	42.4 -5.8	41.5 -4.9	40.9 -3.9	40.7 -2.8	30
25	52.2 -8.8	50.1 -9.8	47.7 -10.4	45.1 -10.7	42.5 -10.6	40.0 -10.1	37.6 -9.5	35.6 -8.6	33.9 -7.6	32.7 -6.4	31.9 -5.1	31.6 -3.8	25
20	47.0 -9.9	44.6 -11.3	41.8 -12.3	38.7 -12.8	35.4 -12.9	32.1 -12.5	29.1 -11.8	26.4 -10.8	24.2 -9.5	22.6 -8.0	21.6 -6.5	21.1 -4.8	20
15	41.2 -10.9	38.6 -12.8	35.3 -14.2	31.5 -15.1	27.5 -15.4	23.5 -15.1	19.6 -14.3	16.3 -13.1	13.5 -11.5	11.4 -9.8	10.1 -7.9	9.4 -6.0	15
10	34.8 -11.7	31.8 -14.1	28.1 -15.9	23.7 -17.2	19.0 -17.7	14.2 -17.5	9.5 -16.7	5.5 -15.2	2.1 -13.4	-.4 -11.3	-2.0 -9.2	-3.0 -7.1	10
5	27.7 -12.3	24.4 -15.1	20.2 -17.4	15.3 -19.0	10.0 -19.7	4.5 -19.6	-.8 -18.6	-5.4 -17.0	-9.2 -14.9	-12.1 -12.6	-14.0 -10.3	-15.2 -8.0	5
0	19.8 -12.7	16.3 -15.8	11.8 -18.4	6.5 -20.2	.7 -21.0	-5.2 -20.9	-10.7 -19.8	-15.7 -18.1	-19.8 -15.9	-22.9 -13.6	-25.1 -11.2	-26.5 -8.9	0
LAT E. LONG	300	305	310	315	320	325	330	335	340	345	350	355	LAT E. LONG

INCLINATION (I) WMM-90

E. LONG / LAT	0	5	10	15	20	25	30	35	40	45	50	55	E. LONG / LAT
0	-27.3 -6.8	-27.7 -5.0	-27.8 -3.4	-27.6 -2.0	-27.2 -.9	-26.4 .1	-25.2 1.0	-23.8 1.8	-22.1 2.5	-20.5 3.1	-19.3 3.5	-18.6 3.7	0
-5	-37.6 -7.6	-38.2 -5.8	-38.6 -4.1	-38.6 -2.6	-38.3 -1.2	-37.6 .0	-36.4 1.1	-34.9 2.1	-33.2 3.0	-31.6 3.6	-30.6 3.9	-29.6 3.9	-5
-10	-46.3 -8.5	-47.1 -6.6	-47.7 -4.6	-48.0 -3.1	-47.8 -1.6	-47.1 -.1	-46.0 1.3	-44.5 2.5	-42.8 3.4	-41.3 4.0	-40.0 4.1	-39.7 4.0	-10
-15	-52.9 -9.2	-54.1 -7.3	-55.0 -5.4	-55.5 -3.6	-55.4 -1.8	-54.8 .0	-53.7 1.6	-52.3 2.9	-50.6 3.8	-49.1 4.3	-47.9 4.3	-47.2 3.8	-15
-20	-57.9 -9.7	-59.4 -7.4	-60.5 -5.8	-61.1 -3.8	-61.1 -1.8	-60.6 .2	-59.5 1.9	-58.0 3.3	-56.6 4.2	-55.0 4.5	-53.9 4.2	-53.3 3.4	-20
-25	-61.5 -9.5	-63.1 -7.7	-64.2 -5.7	-64.8 -3.5	-64.8 -1.4	-64.1 .7	-63.0 2.5	-61.6 3.8	-60.1 4.4	-58.7 4.4	-57.9 3.7	-57.5 2.6	-25
-30	-63.7 -8.5	-65.1 -6.7	-66.1 -4.7	-66.5 -2.6	-66.4 -.4	-65.6 1.5	-64.5 3.1	-63.1 4.1	-61.7 4.3	-60.7 3.8	-60.1 2.8	-60.0 1.5	-30
-35	-64.7 -6.5	-65.7 -4.7	-66.4 -2.8	-66.6 -.8	-66.2 1.1	-65.4 2.7	-64.2 3.8	-63.0 4.2	-61.9 3.8	-61.3 2.8	-61.1 1.5	-61.5 .1	-35
-40	-64.4 -3.5	-65.1 -1.8	-65.4 -.1	-65.3 1.5	-64.8 2.9	-64.0 3.9	-63.0 4.2	-62.1 3.6	-61.5 3.1	-61.3 1.8	-61.5 .4	-62.2 -.9	-40
-45	-63.1 -.1	-63.6 1.4	-63.6 2.7	-63.4 3.8	-63.0 4.5	-62.3 4.8	-61.7 4.5	-61.2 3.6	-61.0 2.4	-61.2 1.1	-61.8 -.3	-62.7 -1.4	-45
-50	-61.5 2.8	-61.7 4.0	-61.8 4.9	-61.6 5.4	-61.3 5.6	-61.0 5.2	-60.8 4.5	-60.7 3.4	-60.9 2.2	-61.4 .9	-62.2 -.2	-63.3 -1.2	-50
-55	-60.2 4.6	-60.4 5.4	-60.4 5.9	-60.4 6.1	-60.4 5.8	-60.4 5.3	-60.5 4.5	-60.7 3.4	-61.2 2.3	-61.9 1.3	-62.8 .3	-63.9 -.4	-55
-60	-59.7 5.1	-59.9 5.6	-60.1 5.8	-60.2 5.8	-60.4 5.5	-60.6 5.0	-60.9 4.3	-61.4 3.5	-62.0 2.6	-62.8 1.8	-63.7 1.1	-64.8 .6	-60
-65	-60.3 4.6	-60.5 4.9	-60.7 5.1	-61.0 5.0	-61.3 4.8	-61.6 4.5	-62.1 4.0	-62.6 3.5	-63.2 2.9	-64.0 2.4	-64.9 1.9	-65.9 1.5	-65
-70	-61.8 3.8	-62.0 4.0	-62.3 4.1	-62.5 4.1	-62.8 4.0	-63.3 3.8	-63.7 3.6	-64.3 3.3	-64.9 3.0	-65.6 2.7	-66.3 2.5	-67.2 2.2	-70
-75	-64.1 3.1	-64.3 3.2	-64.5 3.3	-64.7 3.3	-65.1 3.3	-65.4 3.3	-65.8 3.2	-66.3 3.1	-66.8 2.9	-67.4 2.8	-68.0 2.7	-68.7 2.6	-75
-80	-66.8 2.7	-67.0 2.7	-67.2 2.8	-67.4 2.8	-67.6 2.8	-67.9 2.8	-68.2 2.8	-68.6 2.8	-69.0 2.8	-69.4 2.7	-69.9 2.7	-70.4 2.7	-80
-85	-69.9 2.5	-70.0 2.5	-70.1 2.5	-70.3 2.5	-70.4 2.6	-70.6 2.6	-70.8 2.6	-71.0 2.6	-71.2 2.6	-71.4 2.6	-71.7 2.6	-71.9 2.6	-85
-90	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-90
LAT / E. LONG	0	5	10	15	20	25	30	35	40	45	50	55	LAT / E. LONG

INCLINATION (I) WMM-90

E. LONG / LAT	60	65	70	75	80	85	90	95	100	105	110	115	E. LONG / LAT
0	-18.4 3.7	-18.6 3.7	-19.0 3.7	-19.6 3.7	-20.2 3.7	-20.6 3.8	-20.9 3.8	-20.8 3.8	-20.5 3.6	-19.9 3.2	-19.3 2.6	-18.7 1.8	0
-5	-29.4 3.8	-29.6 3.6	-30.0 3.3	-30.5 3.2	-31.0 3.1	-31.4 3.0	-31.6 2.9	-31.5 2.8	-31.1 2.6	-30.6 2.5	-29.7 1.8	-29.1 1.1	-5
-10	-39.0 3.6	-39.2 3.2	-39.5 2.7	-40.0 2.4	-40.5 2.1	-40.8 2.0	-41.0 1.9	-40.8 1.7	-40.6 1.6	-39.8 1.3	-39.1 1.0	-38.3 .5	-10
-15	-47.0 3.2	-47.1 2.5	-47.5 1.9	-48.0 1.4	-48.4 1.1	-48.8 .9	-49.0 .8	-48.9 .7	-48.5 .6	-47.9 .4	-47.2 .2	-46.5 .0	-15
-20	-53.1 2.5	-53.4 1.6	-53.8 .8	-54.4 .3	-54.9 .0	-55.4 -.2	-55.7 -.3	-55.7 -.3	-55.4 -.3	-54.9 -.3	-54.2 -.3	-53.6 -.3	-20
-25	-57.2 1.5	-58.0 .5	-58.6 -.3	-59.3 -.6	-60.0 -1.1	-60.7 -1.2	-61.1 -1.2	-61.3 -1.1	-61.2 -.9	-60.8 -.8	-60.3 -.7	-59.7 -.6	-25
-30	-60.4 .2	-61.1 -.4	-62.0 -1.5	-63.0 -1.9	-64.0 -2.1	-64.8 -2.0	-65.5 -1.8	-65.9 -1.6	-66.0 -1.4	-65.9 -1.1	-65.5 -.9	-65.1 -.7	-30
-35	-62.2 -1.1	-63.2 -2.0	-64.4 -2.5	-65.6 -2.8	-66.8 -2.7	-67.9 -2.5	-68.9 -2.2	-69.6 -1.9	-70.0 -1.6	-70.1 -1.3	-70.0 -1.0	-69.7 -.8	-35
-40	-63.2 -2.0	-64.5 -2.7	-65.9 -3.1	-67.4 -3.1	-68.8 -3.0	-70.2 -2.6	-71.4 -2.2	-72.5 -1.9	-73.2 -1.5	-73.7 -1.3	-73.8 -1.0	-73.8 -.8	-40
-45	-64.0 -2.3	-65.4 -2.8	-66.9 -3.0	-68.6 -2.9	-70.2 -2.7	-71.8 -2.3	-73.3 -1.9	-74.6 -1.6	-75.7 -1.3	-76.6 -1.1	-77.1 -1.0	-77.3 -.9	-45
-50	-64.8 -1.9	-66.1 -2.3	-67.7 -2.4	-69.4 -2.3	-71.1 -2.0	-72.8 -1.7	-74.5 -1.3	-76.1 -1.1	-77.5 -.9	-78.7 -.8	-79.7 -.8	-80.3 -.9	-50
-55	-65.3 -1.0	-66.7 -1.3	-68.3 -1.3	-70.0 -1.3	-71.7 -1.1	-73.4 -.8	-75.2 -.6	-76.9 -.4	-78.5 -.3	-80.1 -.3	-81.4 -.4	-82.6 -.7	-55
-60	-66.0 .2	-67.4 -.1	-68.9 -.2	-70.4 -.1	-72.1 .0	-73.7 .1	-75.4 .3	-77.1 .4	-78.8 .4	-80.5 .4	-82.1 .3	-83.6 .0	-60
-65	-67.0 1.2	-68.2 1.1	-69.5 .9	-70.9 .9	-72.3 .9	-73.8 1.0	-75.4 1.1	-76.9 1.1	-78.5 1.1	-80.0 1.1	-81.6 1.1	-83.1 1.0	-65
-70	-68.2 2.0	-69.2 1.9	-70.3 1.8	-71.4 1.7	-72.6 1.7	-73.9 1.7	-75.1 1.7	-76.4 1.7	-77.7 1.8	-79.0 1.8	-80.3 1.8	-81.6 1.8	-70
-75	-69.5 2.5	-70.3 2.4	-71.1 2.3	-72.0 2.3	-72.9 2.3	-73.9 2.2	-74.9 2.2	-75.8 2.2	-76.8 2.2	-77.8 2.2	-78.7 2.2	-79.6 2.2	-75
-80	-70.8 2.6	-71.6 2.6	-72.0 2.6	-72.6 2.5	-73.3 2.5	-73.9 2.5	-74.5 2.5	-75.2 2.5	-75.8 2.5	-76.4 2.5	-77.0 2.5	-77.6 2.5	-80
-85	-72.2 2.6	-72.5 2.6	-72.8 2.6	-73.1 2.6	-73.4 2.6	-73.7 2.6	-74.0 2.6	-74.3 2.6	-74.6 2.5	-74.9 2.5	-75.2 2.5	-75.5 2.5	-85
-90	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-90
LAT / E. LONG	60	65	70	75	80	85	90	95	100	105	110	115	LAT / E. LONG

INCLINATION (I) WMM-90

E. LONG / LAT	120	125	130	135	140	145	150	155	160	165	170	175	E. LONG / LAT
0	-18.3 .9	-18.0 -.1	-17.9 -.9	-17.6 -1.5	-17.3 -1.6	-16.6 -1.3	-15.7 -.5	-14.5 .7	-13.0 2.0	-11.1 3.2	-8.9 4.3	-6.6 4.3	0
-5	-28.5 .4	-28.1 -.4	-27.8 -1.0	-27.5 -1.5	-27.0 -1.6	-26.3 -1.4	-25.3 -.8	-24.1 .1	-22.7 1.1	-20.9 2.0	-18.9 2.7	-16.8 3.0	-5
-10	-37.7 .0	-37.2 -.5	-36.8 -.9	-36.4 -1.3	-35.8 -1.4	-35.1 -1.3	-34.2 -1.0	-33.1 -.5	-31.7 .2	-30.2 .8	-28.4 1.3	-26.5 1.6	-10
-15	-45.8 -.2	-45.3 -.5	-44.8 -.8	-44.3 -1.0	-43.7 -1.1	-43.0 -1.2	-42.2 -1.1	-41.2 -.9	-40.0 -.6	-38.6 -.2	-37.0 .1	-35.4 .3	-15
-20	-52.9 -.4	-52.4 -.5	-51.8 -.6	-51.3 -.7	-50.7 -.8	-50.1 -.9	-49.3 -1.0	-48.4 -1.1	-47.3 -1.0	-46.0 -.9	-44.7 -.7	-43.2 -.5	-20
-25	-59.1 -.5	-58.6 -.4	-58.0 -.4	-57.5 -.4	-56.9 -.5	-56.3 -.7	-55.5 -.9	-54.7 -1.1	-53.7 -1.2	-52.6 -1.2	-51.4 -1.1	-50.1 -1.0	-25
-30	-64.5 -.5	-64.0 -.3	-63.5 -.2	-62.9 -.2	-62.4 -.2	-61.7 -.4	-61.0 -.6	-60.2 -.9	-59.3 -1.1	-58.2 -1.2	-57.1 -1.1	-56.0 -1.0	-30
-35	-69.3 -.5	-68.8 -.3	-68.3 -.2	-67.8 -.1	-67.2 -.1	-66.5 -.2	-65.8 -.4	-65.0 -.6	-64.1 -.8	-63.2 -.9	-62.1 -.9	-61.0 -.7	-35
-40	-73.5 -.6	-73.1 -.4	-72.7 -.3	-72.1 -.2	-71.5 -.1	-70.9 -.1	-70.1 -.2	-69.3 -.3	-68.4 -.4	-67.5 -.5	-66.5 -.5	-65.4 -.4	-40
-45	-77.3 -.8	-77.1 -.7	-76.7 -.5	-76.1 -.4	-75.5 -.2	-74.8 -.2	-74.0 -.1	-73.2 -.1	-72.2 -.1	-71.3 -.1	-70.3 -.1	-69.3 .0	-45
-50	-80.6 -1.0	-80.7 -1.0	-80.4 -.9	-79.9 -.7	-79.3 -.5	-78.5 -.3	-77.7 -.2	-76.7 .0	-75.8 .1	-74.8 .1	-73.8 .1	-72.8 .1	-50
-55	-83.4 -1.0	-83.9 -1.3	-83.9 -1.3	-83.5 -1.2	-82.9 -.9	-82.1 -.6	-81.1 -.3	-80.1 -.1	-79.1 .1	-78.1 .2	-77.1 .2	-76.1 .1	-55
-60	-85.0 -.4	-86.2 -1.0	-86.9 -1.5	-87.0 -1.7	-86.4 -1.3	-85.5 -.8	-84.5 -.4	-83.4 -.1	-82.3 .1	-81.2 .2	-80.2 .2	-79.2 .1	-60
-65	-84.6 .9	-86.1 .7	-87.5 .6	-88.9 .5	-89.7 .9	-88.4 .3	-87.2 .3	-86.0 .4	-84.9 .4	-83.8 .4	-82.7 .3	-81.7 .2	-65
-70	-82.8 1.8	-83.9 1.9	-85.0 1.9	-85.9 2.0	-86.5 2.2	-86.8 2.2	-86.7 2.1	-86.2 1.8	-85.6 1.5	-84.8 1.3	-83.9 1.1	-83.1 .9	-70
-75	-80.5 2.3	-81.3 2.3	-82.0 2.3	-82.6 2.4	-83.1 2.4	-83.5 2.4	-83.6 2.4	-83.6 2.3	-83.5 2.2	-83.2 2.1	-82.8 1.9	-82.3 1.8	-75
-80	-78.1 2.5	-78.6 2.5	-79.1 2.5	-79.4 2.5	-79.8 2.5	-80.0 2.5	-80.2 2.5	-80.3 2.4	-80.3 2.4	-80.2 2.4	-80.1 2.3	-79.9 2.3	-80
-85	-75.7 2.5	-75.9 2.5	-76.1 2.5	-76.3 2.5	-76.5 2.5	-76.6 2.5	-76.7 2.5	-76.7 2.5	-76.8 2.5	-76.8 2.5	-76.7 2.4	-76.6 2.4	-85
-90	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-90
LAT / E. LONG	120	125	130	135	140	145	150	155	160	165	170	175	LAT / E. LONG

INCLINATION (I) WMM-90

E. LONG	180	185	190	195	200	205	210	215	220	225	230	235	E. LONG
LAT													LAT
0	-4.4 3.9	-2.3 2.9	-.6 1.3	.7 -.7	1.8 -2.7	2.7 -4.4	3.6 -5.5	4.6 -5.7	5.5 -5.0	6.4 -3.3	7.3 -1.0	8.2 1.8	0
-5	-14.7 2.8	-12.8 2.0	-11.2 .7	-9.9 -.8	-8.7 -2.5	-7.7 -3.9	-6.7 -4.8	-5.7 -4.9	-4.7 -4.0	-3.7 -2.3	-2.7 .1	-1.7 3.0	-5
-10	-24.6 1.5	-22.9 1.0	-21.4 .2	-20.1 -.9	-18.9 -2.1	-17.9 -3.0	-16.8 -3.6	-15.8 -3.4	-14.7 -2.5	-13.6 -.9	-12.5 1.4	-11.5 4.1	-10
-15	-33.7 .4	-32.2 .2	-30.7 -.2	-29.5 -.8	-28.4 -1.4	-27.3 -1.9	-26.2 -2.1	-25.1 -1.8	-24.0 -.9	-22.8 .6	-21.7 2.6	-20.6 4.8	-15
-20	-41.8 -.4	-40.4 -.3	-39.1 -.3	-37.9 -.5	-36.7 -.6	-35.7 -.8	-34.6 -.7	-33.5 -.3	-32.3 .6	-31.2 1.8	-30.1 3.3	-29.0 5.0	-20
-25	-48.8 -.7	-47.5 -.5	-46.3 -.3	-45.1 -.1	-44.0 .0	-42.9 .2	-41.9 .4	-40.8 .8	-39.7 1.5	-38.6 2.4	-37.5 3.5	-36.5 4.6	-25
-30	-54.8 -.7	-53.6 -.4	-52.4 -.1	-51.3 .2	-50.3 .5	-49.2 .7	-48.2 1.0	-47.2 1.3	-46.1 1.7	-45.1 2.3	-44.1 3.0	-43.0 3.7	-30
-35	-59.9 -.5	-58.8 -.2	-57.7 .1	-56.7 .4	-55.7 .6	-54.7 .8	-53.7 1.0	-52.7 1.2	-51.8 1.4	-50.8 1.7	-49.8 2.1	-48.8 2.5	-35
-40	-64.4 -.2	-63.3 .0	-62.3 .2	-61.3 .4	-60.4 .5	-59.4 .5	-58.5 .5	-57.6 .6	-56.7 .6	-55.7 .8	-54.7 1.0	-53.7 1.3	-40
-45	-68.3 .0	-67.3 .1	-66.4 .1	-65.4 .1	-64.5 .1	-63.6 .0	-62.7 -.1	-61.9 -.2	-61.0 -.3	-60.0 -.2	-59.0 -.1	-58.0 .2	-45
-50	-71.9 .1	-70.9 .0	-70.0 -.1	-69.1 -.2	-68.2 -.4	-67.4 -.6	-66.5 -.8	-65.6 -1.0	-64.7 -1.0	-63.8 -1.0	-62.7 -.8	-61.6 -.5	-50
-55	-75.2 .0	-74.2 -.1	-73.3 -.3	-72.4 -.6	-71.6 -.8	-70.7 -1.1	-69.8 -1.3	-68.9 -1.4	-68.0 -1.4	-67.0 -1.3	-65.9 -1.0	-64.7 -.7	-55
-60	-78.2 -.1	-77.3 -.2	-76.3 -.5	-75.4 -.7	-74.6 -.9	-73.7 -1.1	-72.8 -1.3	-71.8 -1.3	-70.8 -1.3	-69.8 -1.1	-68.6 -.8	-67.4 -.4	-60
-65	-80.8 .1	-79.8 -.1	-78.9 -.3	-78.0 -.5	-77.1 -.6	-76.1 -.7	-75.2 -.8	-74.2 -.8	-73.2 -.6	-72.1 -.4	-71.0 -.2	-69.8 .2	-65
-70	-82.2 .7	-81.3 .5	-80.5 .4	-79.6 .3	-78.7 .2	-77.8 .1	-76.8 .1	-75.9 .2	-74.9 .3	-73.9 .5	-72.8 .7	-71.7 .9	-70
-75	-81.8 1.6	-81.1 1.5	-80.5 1.4	-79.8 1.3	-79.0 1.2	-78.3 1.2	-77.5 1.2	-76.7 1.2	-75.8 1.3	-75.0 1.3	-74.1 1.4	-73.2 1.5	-75
-80	-79.6 2.2	-79.3 2.2	-78.9 2.1	-78.4 2.1	-78.0 2.0	-77.5 2.0	-76.9 2.0	-76.4 2.0	-75.8 2.0	-75.2 2.0	-74.6 2.0	-74.0 2.0	-80
-85	-76.5 2.4	-76.4 2.4	-76.3 2.4	-76.1 2.4	-75.9 2.4	-75.6 2.3	-75.4 2.3	-75.1 2.3	-74.9 2.3	-74.6 2.3	-74.3 2.3	-74.0 2.3	-85
-90	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-90
LAT													LAT
E. LONG	180	185	190	195	200	205	210	215	220	225	230	235	E. LONG

INCLINATION (I) WMM-90

E. LONG / LAT	240	245	250	255	260	265	270	275	280	285	290	295	E. LONG / LAT
0	9.2 4.6	10.4 7.1	11.8 8.9	13.5 9.8	15.6 9.8	17.7 8.8	19.9 6.9	21.8 4.4	23.1 1.3	23.8 -2.1	23.5 -5.7	22.2 -9.5	0
-5	-.7 5.8	.5 8.3	2.0 10.1	3.7 10.9	5.8 10.7	8.1 9.5	10.4 7.5	12.5 4.8	14.2 1.6	15.0 -1.9	14.9 -5.6	13.7 -9.4	-5
-10	-10.4 6.7	-9.2 8.9	-7.6 10.4	-6.1 11.1	-4.1 10.7	-1.8 9.4	.6 7.4	2.8 4.7	4.6 1.6	5.7 -1.9	5.8 -5.5	4.6 -9.2	-10
-15	-19.5 7.0	-18.4 8.8	-17.1 9.9	-15.5 10.3	-13.6 9.8	-11.5 8.6	-9.2 6.6	-6.9 4.0	-5.0 1.1	-3.8 -2.1	-3.6 -5.6	-4.5 -9.0	-15
-20	-27.9 6.6	-26.8 7.6	-25.6 8.7	-24.2 8.6	-22.5 8.3	-20.5 7.1	-18.3 5.3	-16.2 3.0	-14.3 .4	-13.0 -2.5	-12.6 -5.8	-13.3 -8.8	-20
-25	-35.4 5.7	-34.3 6.6	-33.2 7.0	-31.8 7.0	-30.3 6.5	-28.5 5.4	-26.5 3.9	-24.5 1.6	-22.7 -.3	-21.3 -2.8	-20.3 -5.5	-21.3 -8.3	-25
-30	-42.0 4.4	-40.9 5.0	-39.9 5.2	-38.4 5.2	-36.9 4.7	-35.3 3.8	-33.4 2.6	-31.5 1.1	-29.6 -.8	-28.5 -2.9	-27.9 -5.2	-28.2 -7.6	-30
-35	-47.7 3.0	-46.6 3.3	-45.4 3.5	-44.0 3.5	-42.5 3.3	-40.9 2.7	-39.1 1.8	-37.4 .6	-35.8 -.8	-34.5 -2.5	-33.9 -4.5	-34.0 -6.5	-35
-40	-52.6 1.6	-51.4 1.9	-50.1 2.2	-48.7 2.3	-47.2 2.3	-45.5 2.0	-43.8 1.5	-42.2 .6	-40.7 -.5	-39.5 -1.8	-38.8 -3.4	-38.8 -5.1	-40
-45	-56.8 .6	-55.5 .9	-54.1 1.3	-52.7 1.6	-51.1 1.8	-49.4 1.8	-47.8 1.5	-46.2 1.0	-44.8 .2	-43.7 -.8	-43.0 -2.1	-42.9 -3.5	-45
-50	-60.4 -.1	-59.0 .4	-57.6 .9	-56.1 1.3	-54.5 1.6	-52.9 1.8	-51.3 1.7	-49.8 1.4	-48.5 .9	-47.5 .1	-46.8 -.8	-46.6 -1.9	-50
-55	-63.4 -.2	-62.1 .3	-60.6 .8	-59.1 1.3	-57.6 1.7	-56.1 1.9	-54.6 2.0	-53.2 1.8	-52.1 1.5	-51.1 .9	-50.5 .2	-50.1 -.6	-55
-60	-66.2 .0	-64.8 .5	-63.4 1.0	-62.0 1.4	-60.6 1.8	-59.2 2.0	-57.9 2.1	-56.7 2.0	-55.6 1.8	-54.8 1.4	-54.2 1.0	-53.8 .4	-60
-65	-68.6 .5	-67.3 .9	-66.0 1.3	-64.8 1.6	-63.5 1.9	-62.3 2.0	-61.2 2.1	-60.2 2.1	-59.2 1.9	-58.5 1.7	-57.9 1.4	-57.5 1.1	-65
-70	-70.6 1.1	-69.6 1.4	-68.5 1.6	-67.4 1.8	-66.3 1.9	-65.3 2.0	-64.4 2.1	-63.6 2.0	-62.8 2.0	-62.1 1.8	-61.6 1.7	-61.1 1.5	-70
-75	-72.3 1.6	-71.4 1.8	-70.6 1.8	-69.7 1.9	-68.8 2.0	-68.1 2.0	-67.4 2.0	-66.7 2.0	-66.1 2.0	-65.5 1.9	-65.0 1.9	-64.6 1.8	-75
-80	-73.4 2.0	-72.8 2.1	-72.2 2.1	-71.6 2.1	-71.0 2.1	-70.5 2.1	-69.9 2.1	-69.4 2.1	-69.0 2.1	-68.6 2.1	-68.2 2.1	-67.9 2.1	-80
-85	-73.7 2.3	-73.4 2.3	-73.1 2.3	-72.8 2.3	-72.5 2.3	-72.2 2.3	-71.9 2.3	-71.6 2.3	-71.4 2.3	-71.1 2.3	-70.9 2.3	-70.7 2.3	-85
-90	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-90
LAT / E. LONG	240	245	250	255	260	265	270	275	280	285	290	295	LAT / E. LONG

INCLINATION (I) WMM-90

E. LONG / LAT	300	305	310	315	320	325	330	335	340	345	350	355	E. LONG / LAT
0	19.8 -12.7	16.3 -15.8	11.8 -18.4	6.5 -20.2	.7 -21.0	-5.2 -20.9	-10.7 -19.8	-15.7 -18.1	-19.8 -15.9	-22.9 -13.6	-25.1 -11.2	-26.5 -8.9	0
-5	11.6 -12.9	7.6 -16.1	3.0 -18.8	-2.5 -20.6	-8.3 -21.4	-14.3 -21.3	-19.9 -20.3	-24.9 -18.6	-29.1 -16.5	-32.3 -14.2	-34.8 -11.9	-38.5 -8.7	-5
-10	2.3 -12.7	-1.3 -15.9	-5.9 -18.5	-11.2 -20.3	-16.9 -21.1	-22.6 -21.0	-28.0 -20.1	-32.8 -18.6	-36.9 -16.8	-40.2 -14.7	-42.7 -12.6	-44.7 -10.5	-10
-15	-6.7 -12.4	-10.9 -15.3	-14.3 -17.7	-18.3 -19.3	-24.6 -20.1	-29.8 -20.1	-34.8 -19.4	-39.3 -18.2	-43.1 -16.6	-46.6 -14.9	-49.0 -13.0	-51.2 -11.1	-15
-20	-15.2 -11.8	-18.2 -14.4	-22.1 -16.6	-26.6 -18.0	-31.3 -18.7	-36.0 -18.7	-40.4 -18.3	-44.5 -17.3	-48.1 -16.1	-51.2 -14.7	-53.8 -13.2	-56.1 -11.5	-20
-25	-22.8 -11.0	-25.4 -13.3	-28.8 -15.1	-32.8 -16.4	-36.9 -17.0	-41.1 -17.2	-45.0 -16.8	-48.7 -16.1	-51.9 -15.2	-54.9 -14.0	-57.4 -12.7	-59.6 -11.2	-25
-30	-29.6 -9.9	-31.6 -11.9	-34.5 -13.6	-37.9 -14.6	-41.5 -15.2	-45.2 -15.5	-48.7 -15.1	-51.9 -14.5	-54.9 -13.7	-57.6 -12.7	-59.9 -11.5	-62.0 -10.1	-30
-35	-34.9 -8.5	-36.7 -10.5	-39.1 -11.7	-42.0 -12.7	-45.2 -13.2	-48.4 -13.3	-51.4 -13.0	-54.3 -12.5	-57.0 -11.7	-59.3 -10.7	-61.6 -9.5	-63.2 -8.1	-35
-40	-39.5 -6.8	-40.9 -8.4	-42.8 -9.6	-45.3 -10.4	-47.9 -10.9	-50.7 -10.9	-53.3 -10.6	-55.8 -9.9	-58.1 -9.0	-60.1 -7.9	-61.8 -6.6	-63.3 -5.2	-40
-45	-43.3 -4.9	-44.3 -6.2	-45.9 -7.2	-47.8 -7.9	-50.0 -8.2	-52.2 -8.1	-54.4 -7.7	-56.5 -6.9	-58.4 -5.9	-60.0 -4.6	-61.3 -3.2	-62.4 -1.7	-45
-50	-46.8 -3.0	-47.5 -4.0	-48.6 -4.8	-50.0 -5.3	-51.6 -5.5	-53.4 -5.3	-55.1 -4.7	-56.7 -3.8	-58.1 -2.7	-59.3 -1.4	-60.3 .0	-61.0 1.5	-50
-55	-50.2 -1.4	-50.6 -2.1	-51.2 -2.6	-52.2 -2.9	-53.3 -3.0	-54.5 -2.7	-55.7 -2.1	-56.8 -1.2	-57.8 -.1	-58.6 1.1	-59.3 2.4	-59.8 3.6	-55
-60	-53.6 -.1	-53.7 -.5	-54.1 -.9	-54.6 -1.0	-55.2 -1.0	-55.9 -.6	-56.7 -.1	-57.4 .6	-58.0 1.5	-58.6 2.5	-59.0 3.4	-59.4 4.3	-60
-65	-57.2 .8	-57.1 .5	-57.2 .4	-57.4 .3	-57.6 .4	-58.0 .7	-58.4 1.1	-58.7 1.6	-59.1 2.3	-59.4 2.9	-59.8 3.6	-60.0 4.1	-65
-70	-60.8 1.4	-60.6 1.3	-60.5 1.2	-60.4 1.2	-60.5 1.3	-60.6 1.5	-60.7 1.8	-60.9 2.1	-61.0 2.4	-61.2 2.8	-61.4 3.2	-61.6 3.5	-70
-75	-64.3 1.8	-64.0 1.7	-63.8 1.7	-63.7 1.8	-63.6 1.8	-63.5 1.9	-63.5 2.1	-63.5 2.2	-63.6 2.4	-63.7 2.6	-63.8 2.8	-63.9 3.0	-75
-80	-67.6 2.1	-67.3 2.1	-67.1 2.1	-66.9 2.1	-66.8 2.1	-66.7 2.2	-66.6 2.2	-66.6 2.3	-66.6 2.4	-66.6 2.5	-66.6 2.5	-66.7 2.6	-80
-85	-70.5 2.3	-70.4 2.3	-70.2 2.3	-70.1 2.3	-70.0 2.3	-69.9 2.3	-69.9 2.4	-69.8 2.4	-69.8 2.4	-69.8 2.4	-69.8 2.4	-69.9 2.5	-85
-90	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-73.2 2.5	-90
LAT / E. LONG	300	305	310	315	320	325	330	335	340	345	350	355	LAT / E. LONG

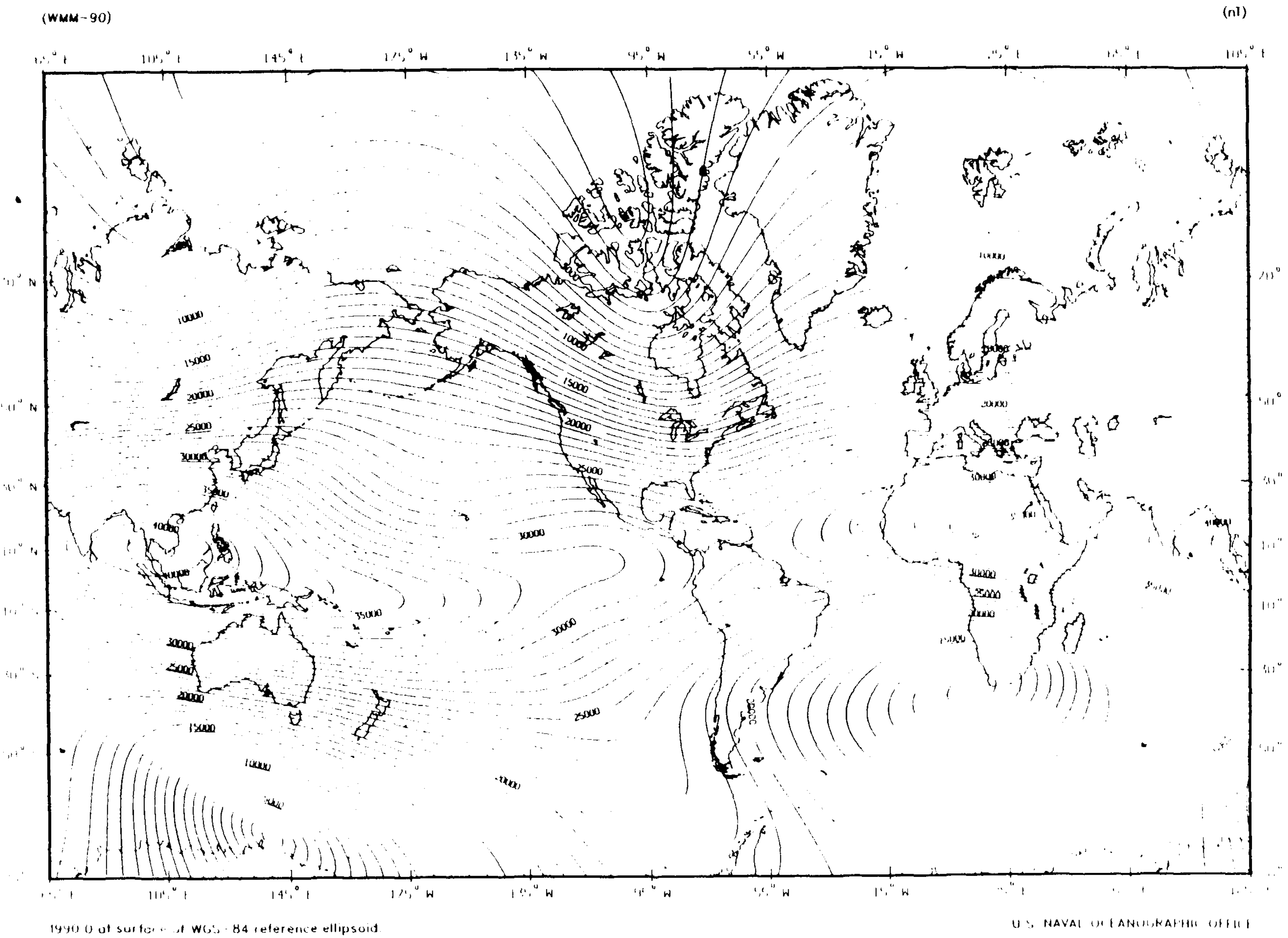
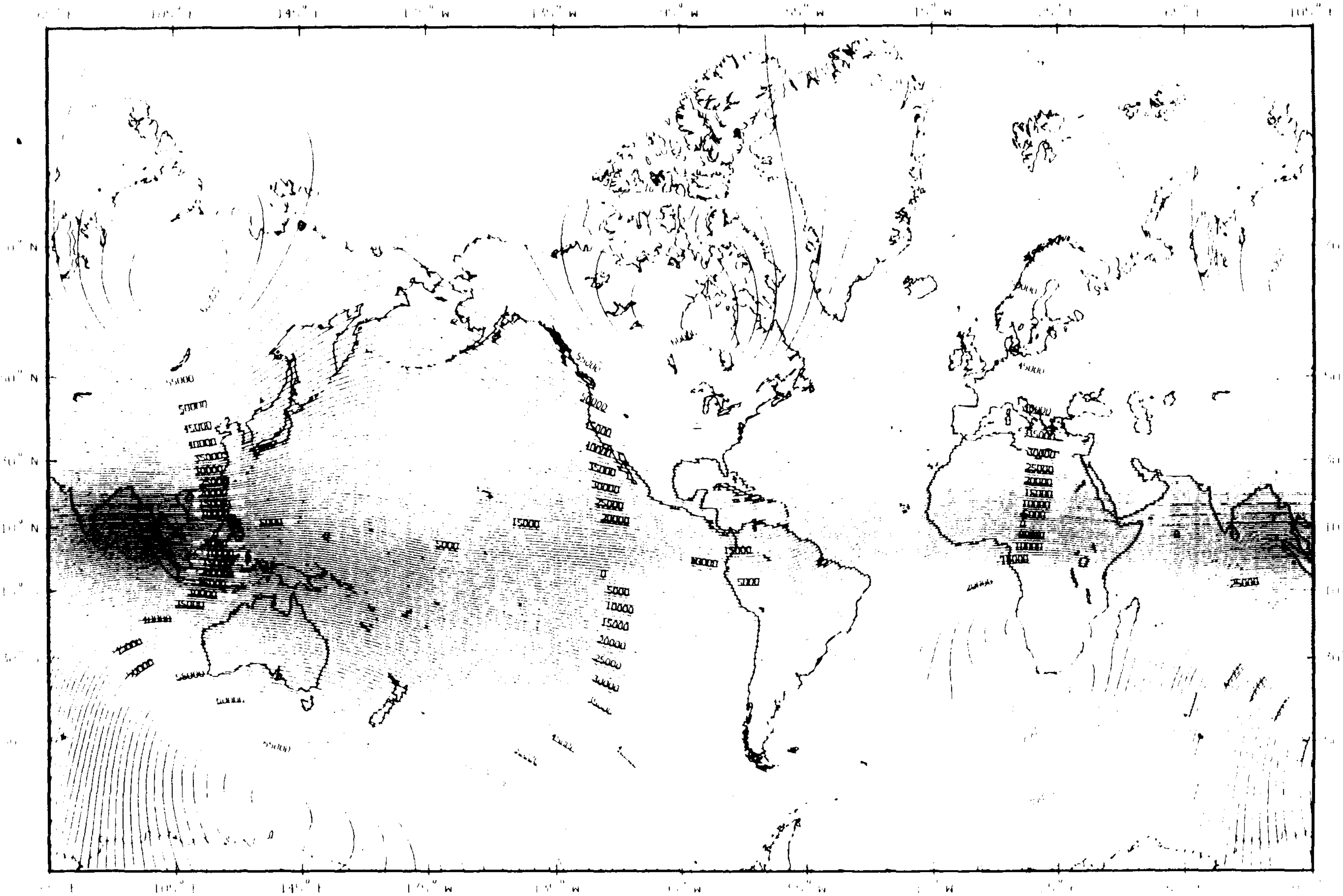


CHART 8. HORIZONTAL INTENSITY (*H*)

(WMM-90) (nT)



1990.0 at surface of WGS-84 reference ellipsoid.

U.S. NAVAL OCEANOGRAPHIC OFFICE

CHART 9. VERTICAL COMPONENT (Z)

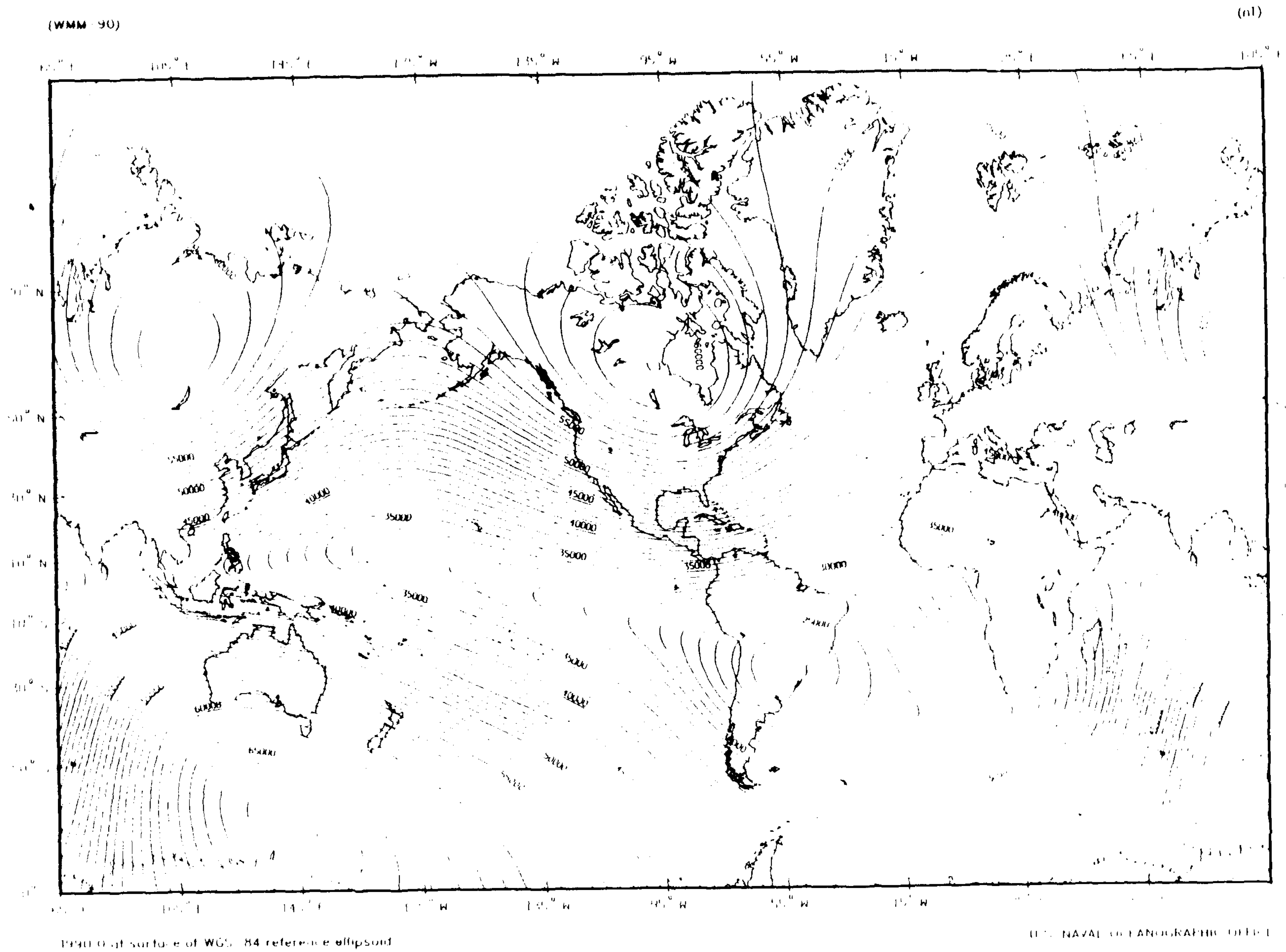


CHART 10. TOTAL INTENSITY (*F*)

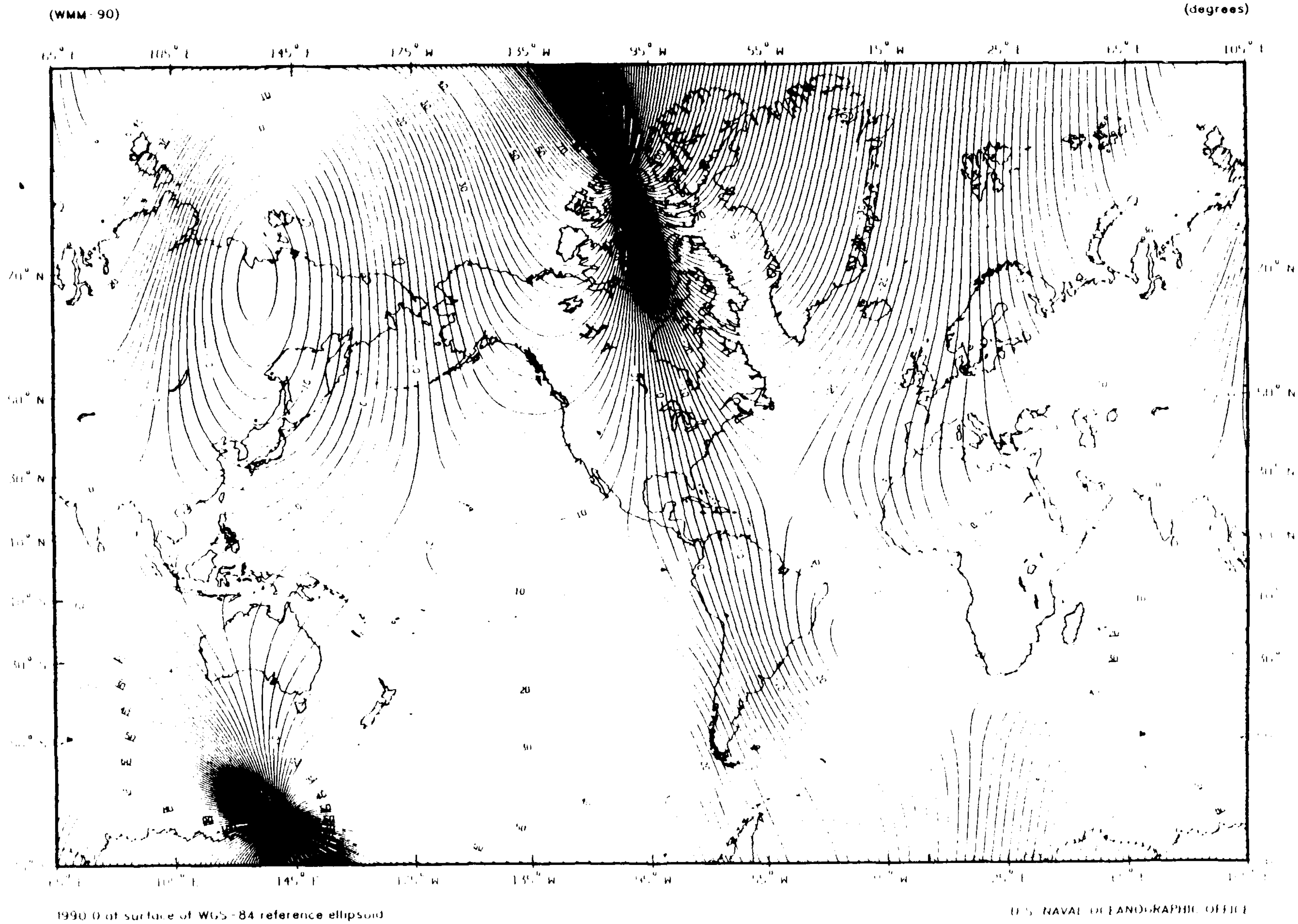


CHART 11. DECLINATION (*D*)

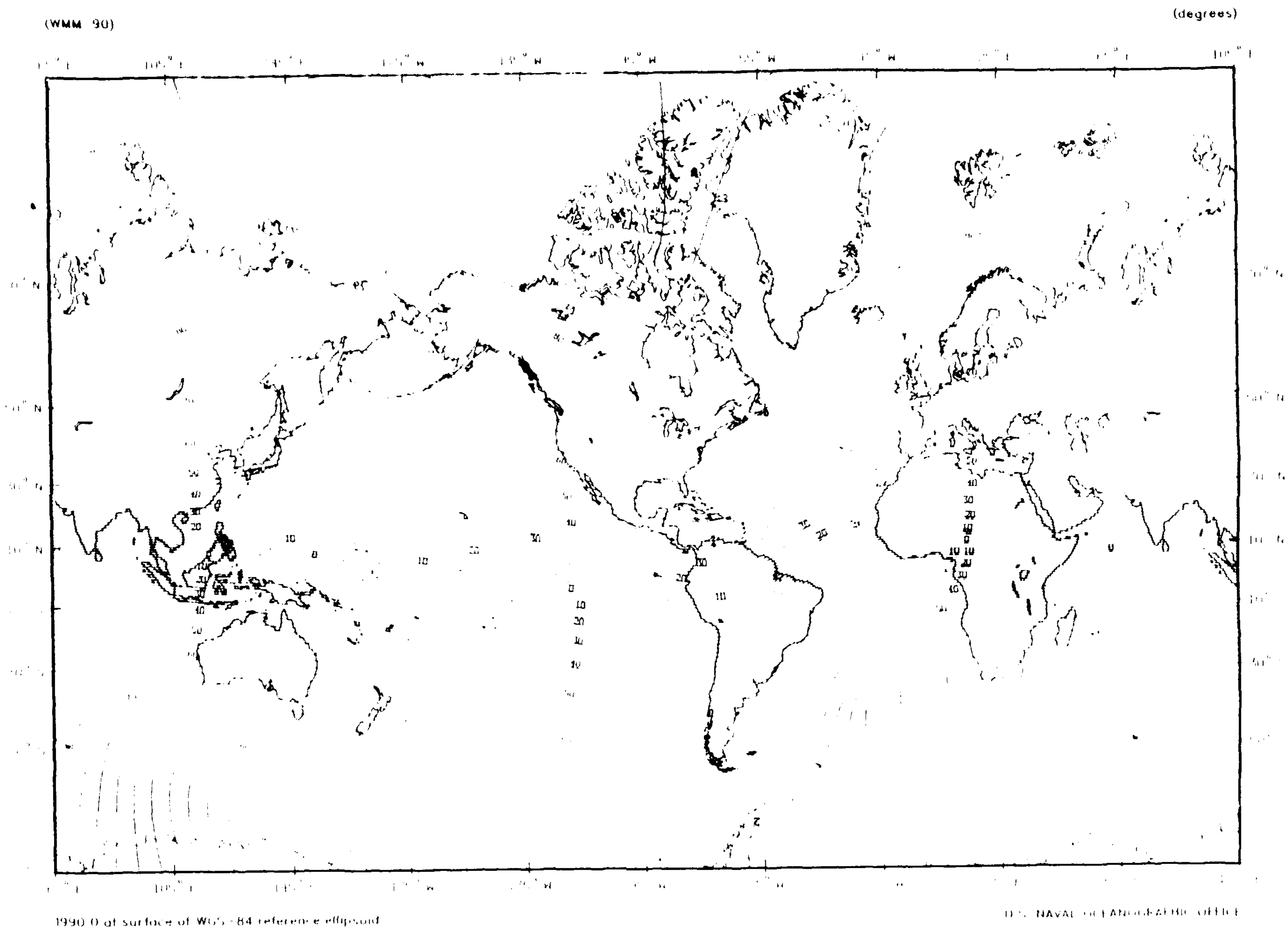
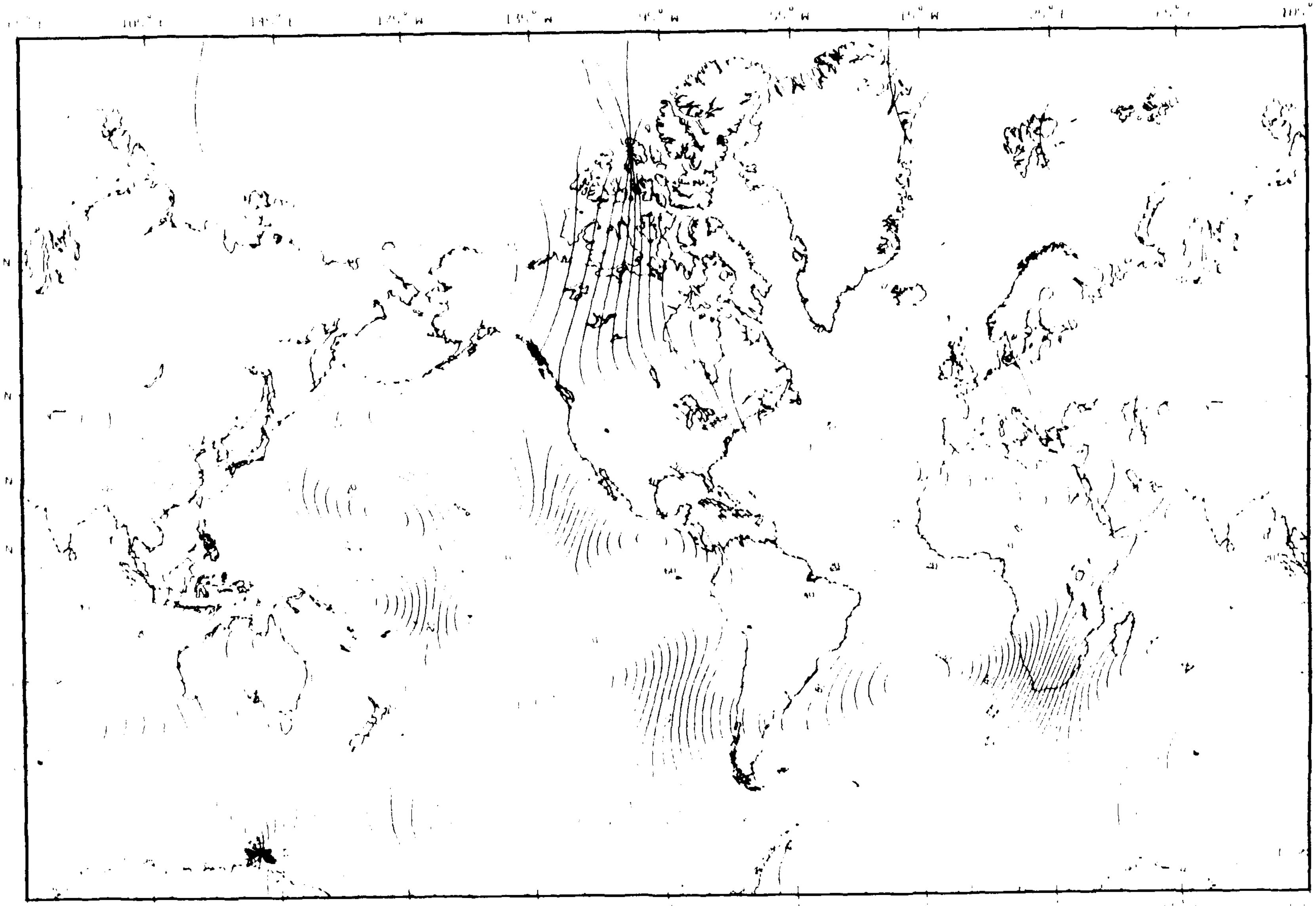


CHART 12. INCLINATION (I)

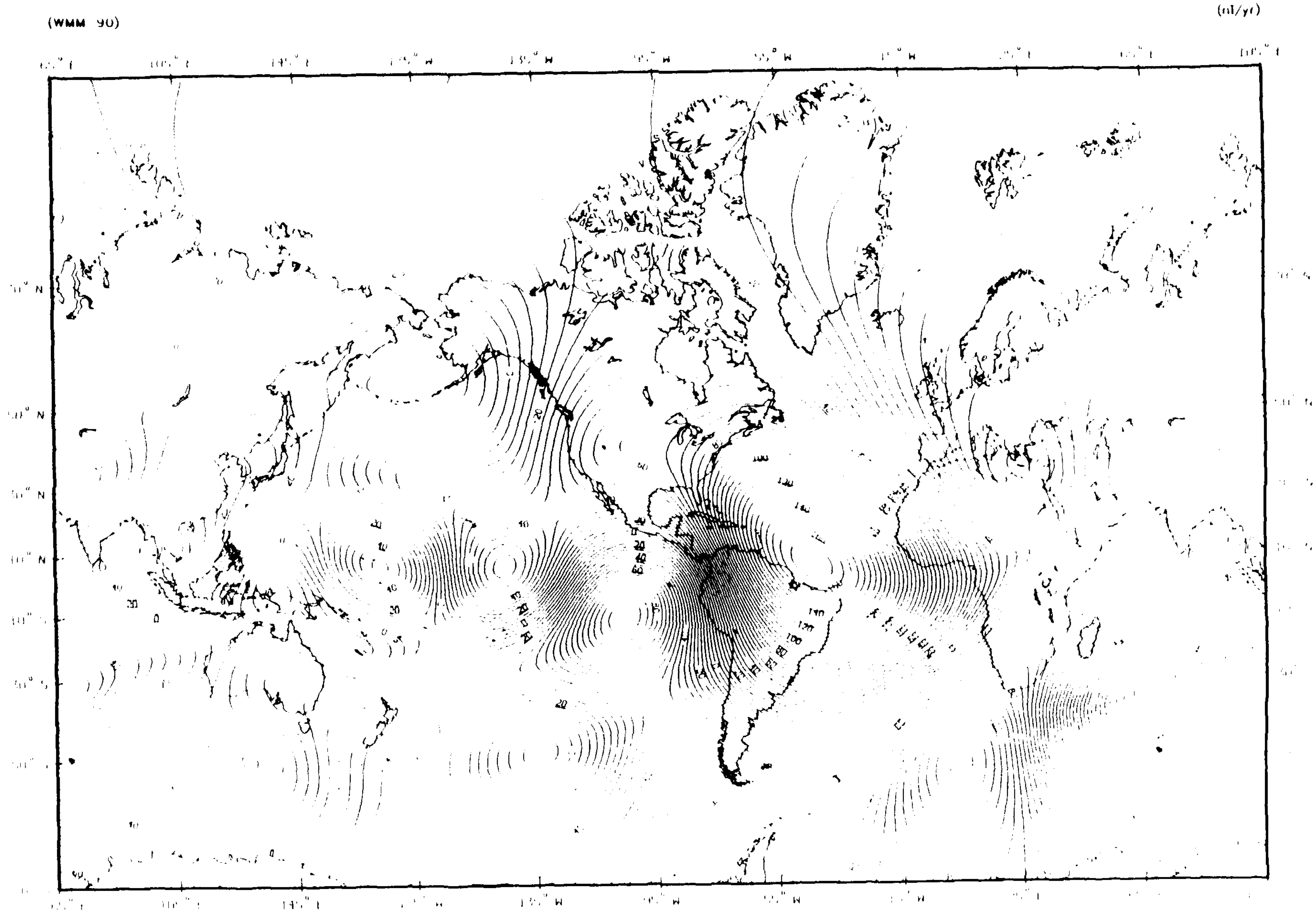
(WMM-90)

(nT/yr)



U.S. NAVAL OCEANOGRAPHIC OFFICE

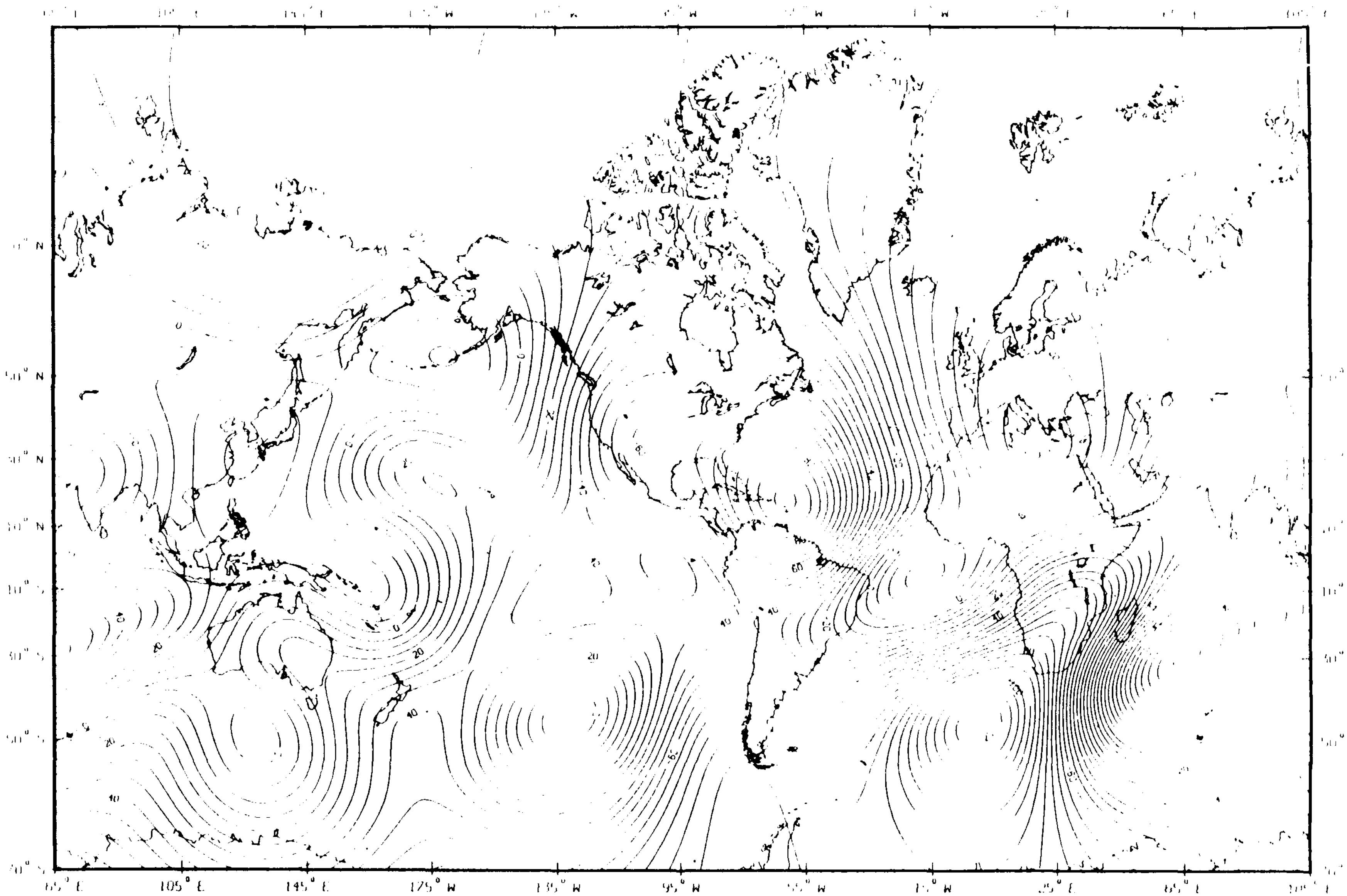
CHART 13. HORIZONTAL INTENSITY ($\dot{H}$)



1990.0 at surface of WGS 84 reference ellipsoid

U.S. NAVAL OCEANOGRAPHIC OFFICE

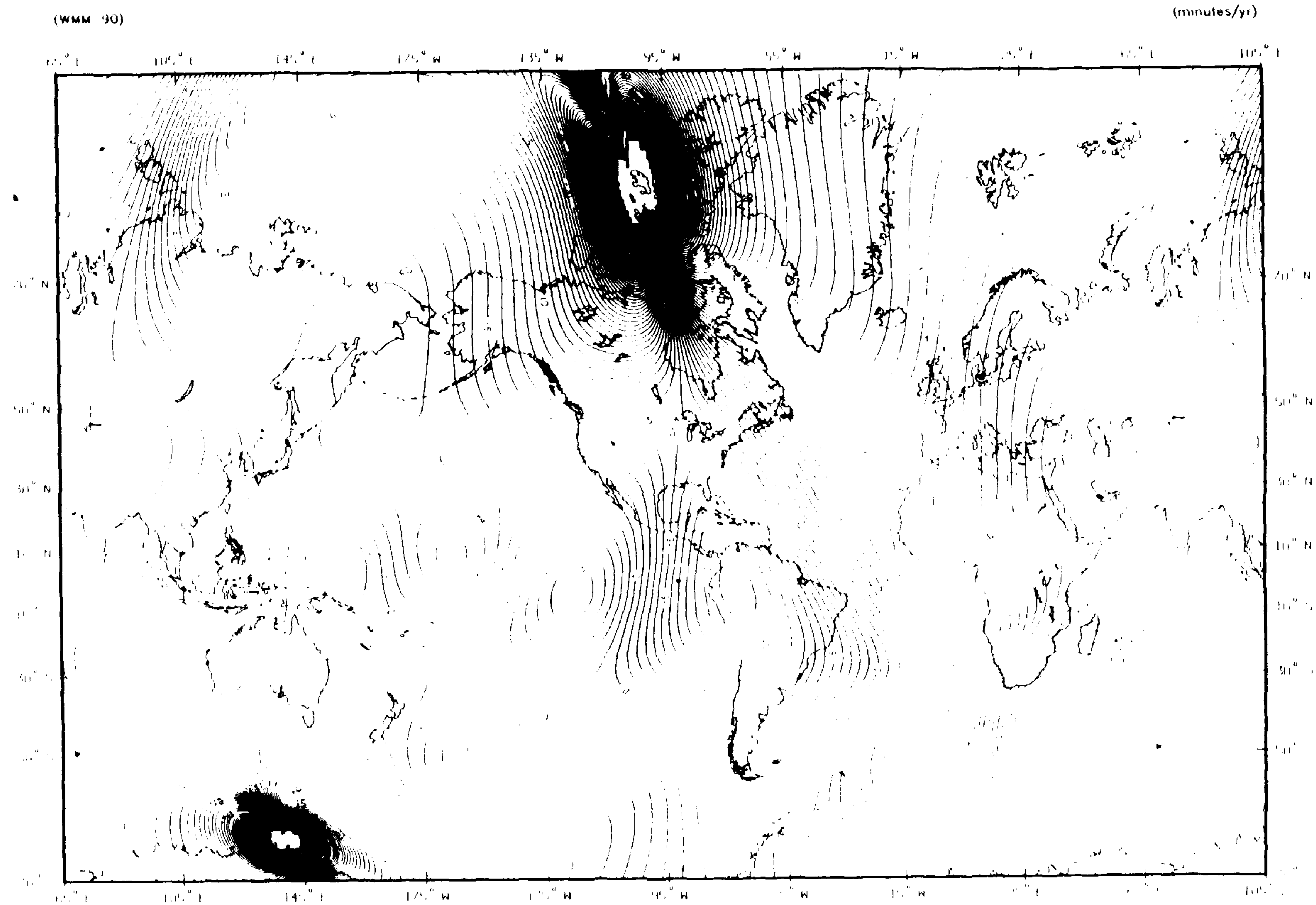
CHART 14. VERTICAL COMPONENT ($\dot{Z}$)



1990.0 at surface of WGS-84 reference ellipsoid.

U.S. NAVAL OCEANOGRAPHIC OFFICE

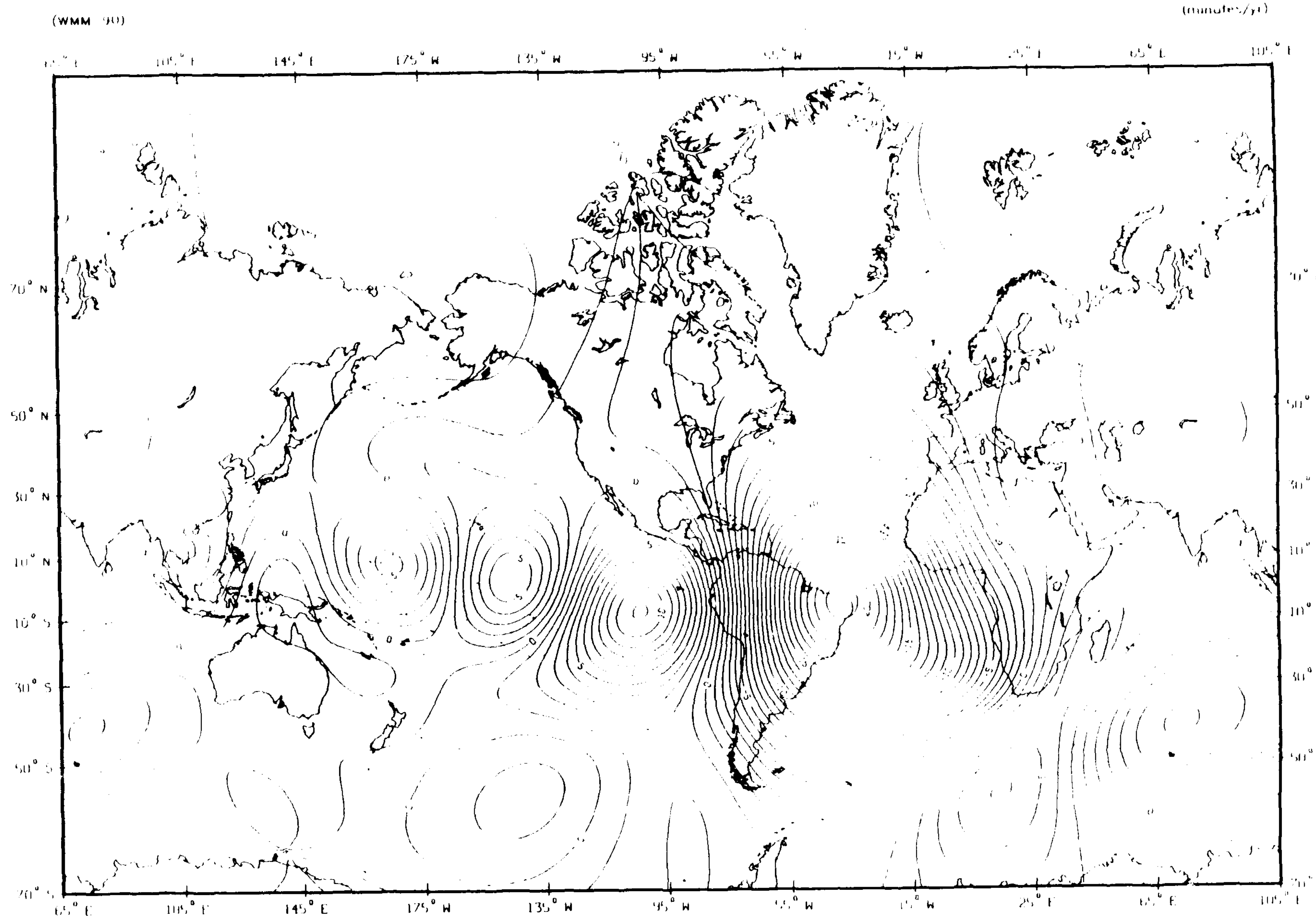
CHART 15. TOTAL INTENSITY ($\dot{F}$)



1990.0 at surface of WGS 84 reference ellipsoid

U.S. NAVAL OCEANOGRAPHIC OFFICE

CHART 16. DECLINATION ($\dot{D}$)



1990.0 at surface of WGS-84 reference ellipsoid.

U.S. NAVAL OCEANOGRAPHIC OFFICE

CHART 17. INCLINATION ($\dot{I}$)

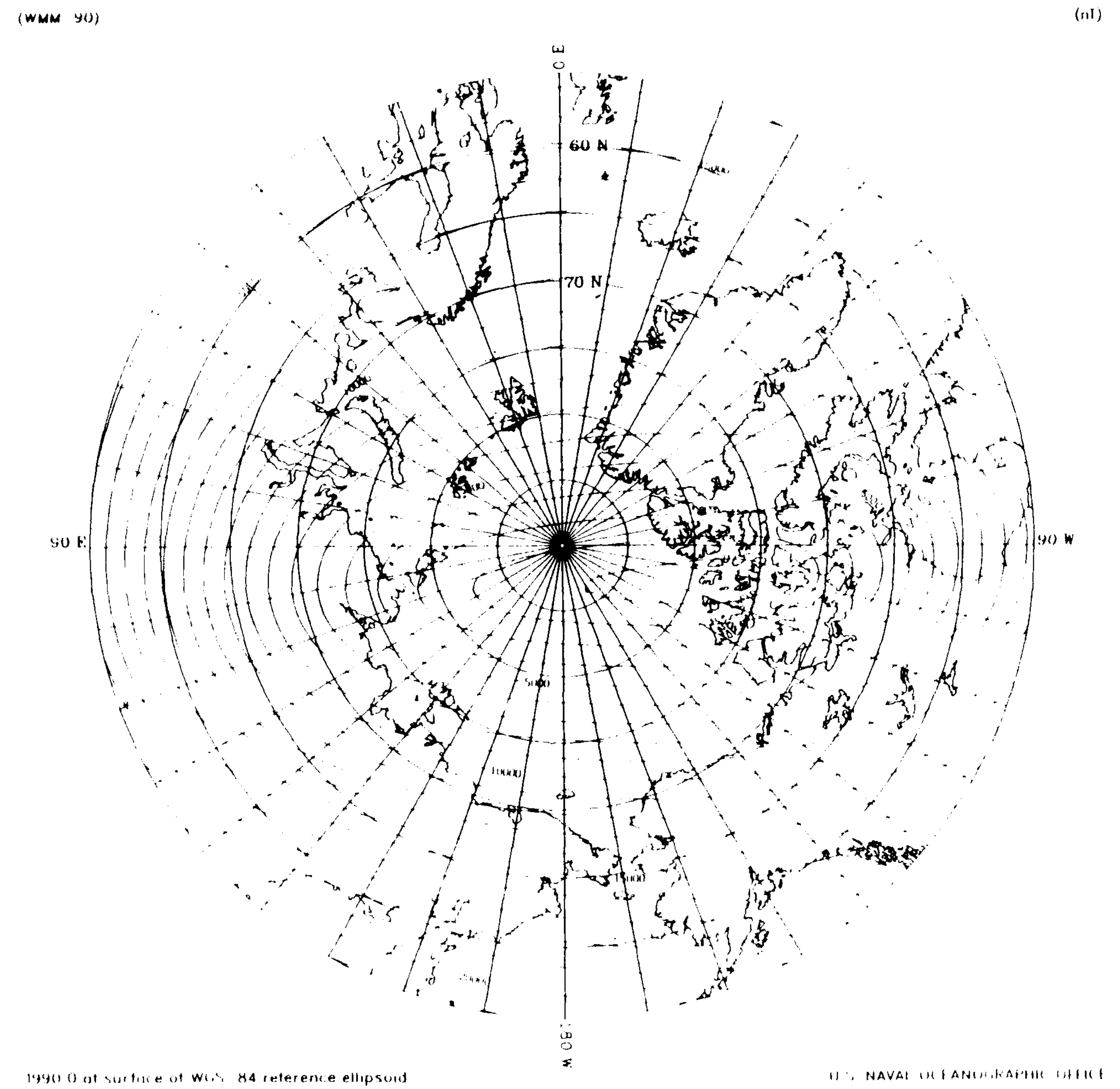
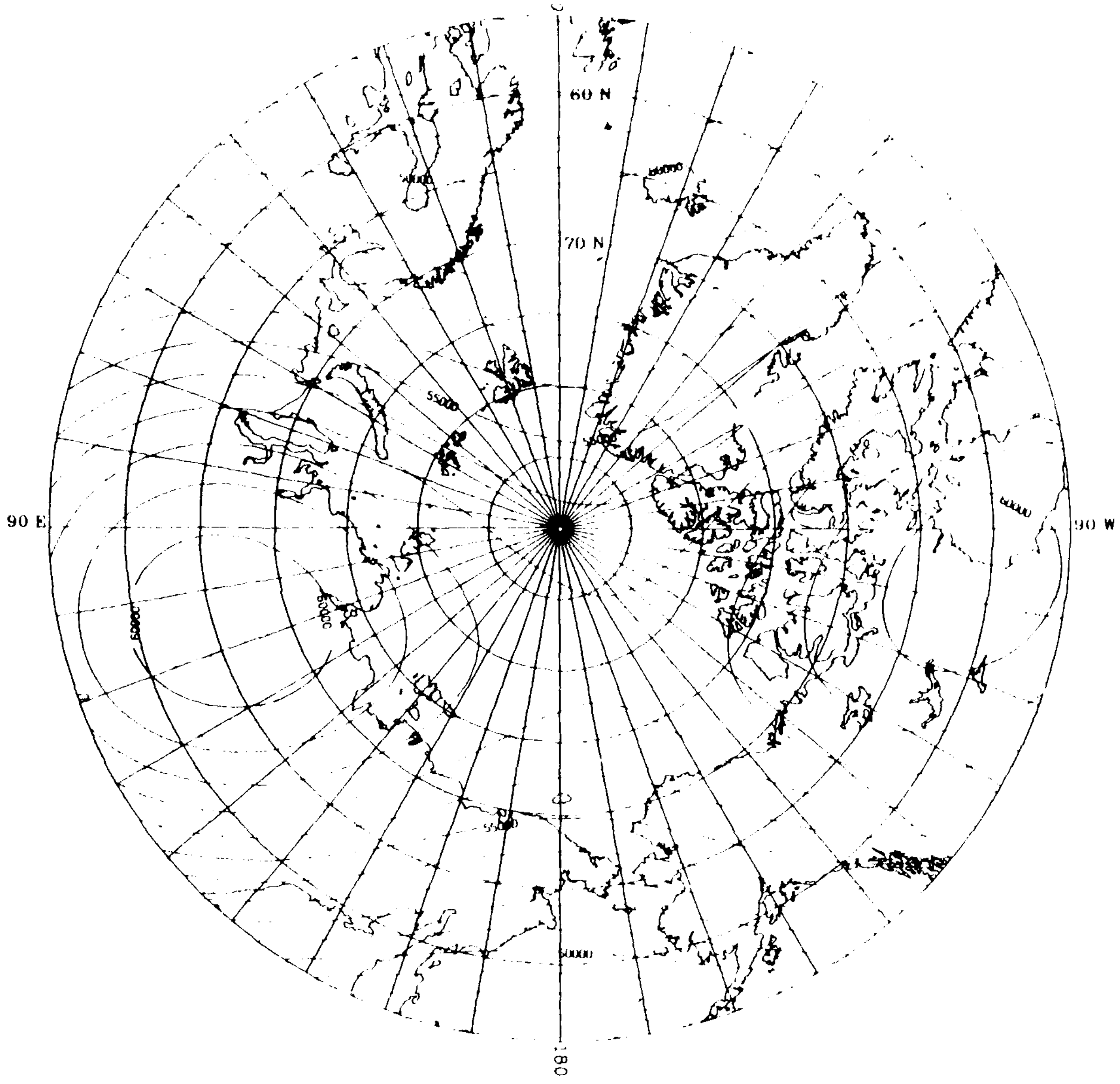


CHART 18. HORIZONTAL INTENSITY (*H*)

(WMM-90) (nT)

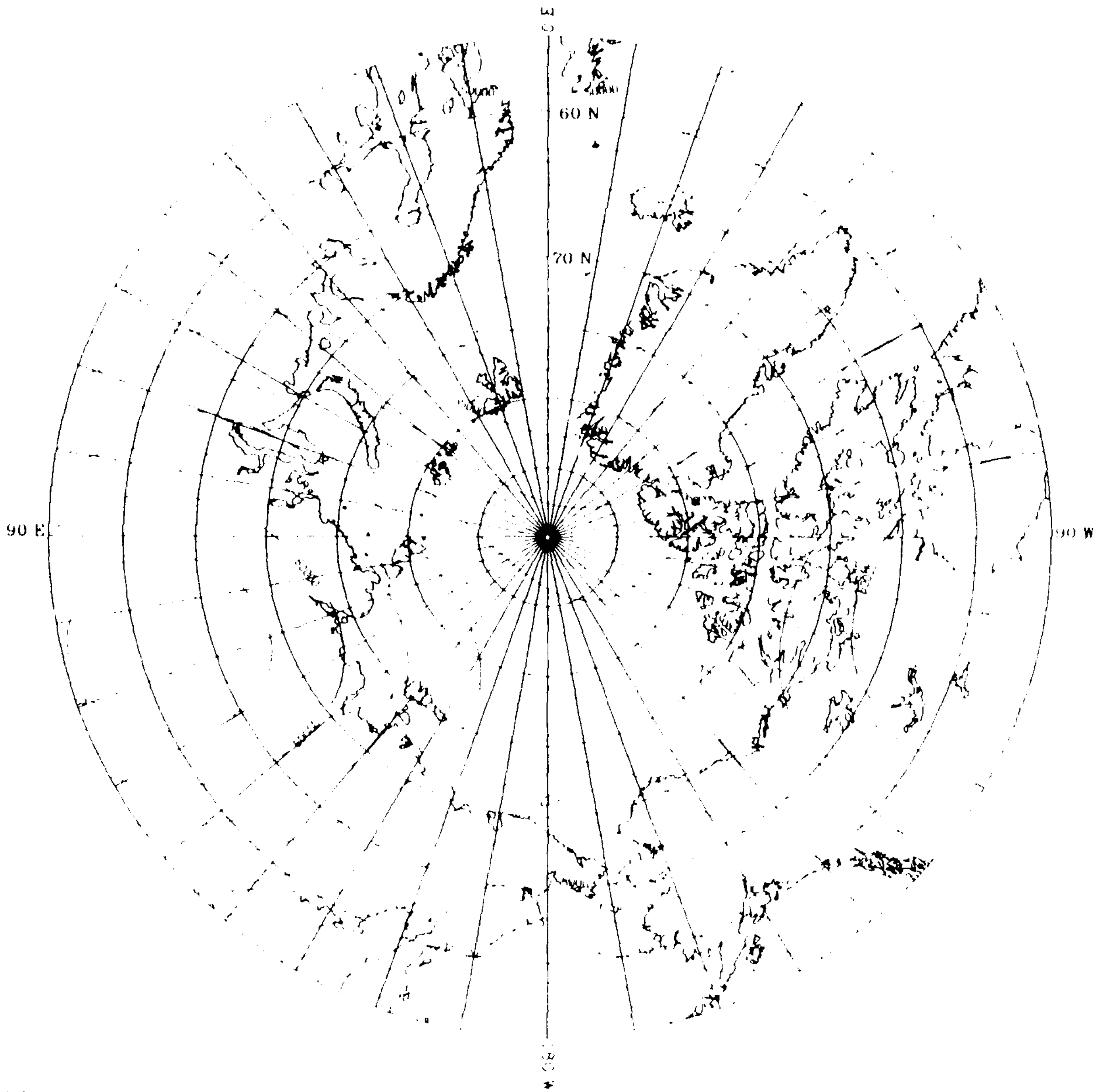


1990.0 at surface of WGS-84 reference ellipsoid

U.S. NAVAL OCEANOGRAPHIC OFFICE

CHART 19. VERTICAL COMPONENT (Z)

(WMM-90) (nT)



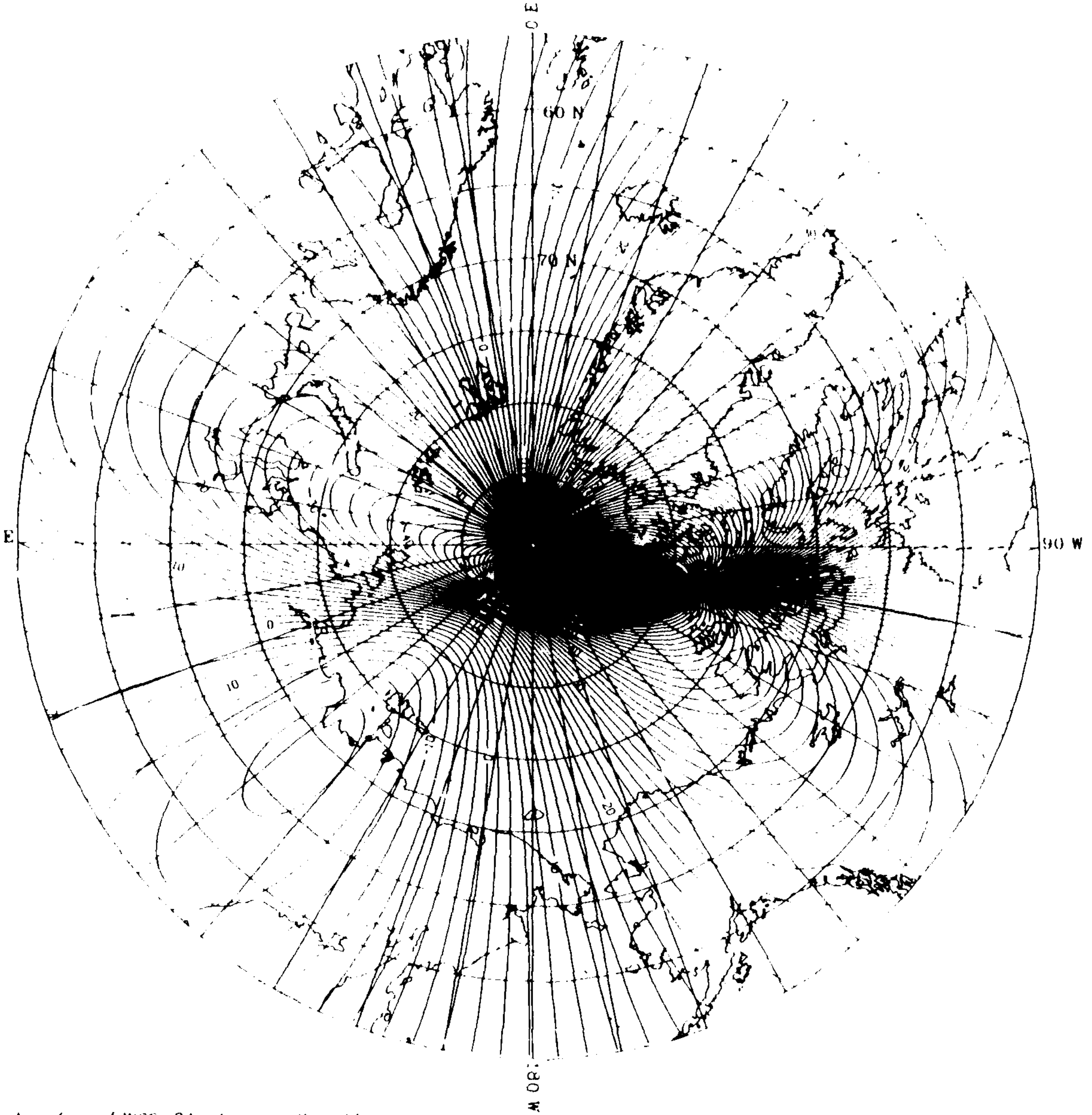
1990.0 at surface of WGS-84 reference ellipsoid

U.S. NAVAL OCEANOGRAPHIC OFFICE

CHART 20. TOTAL INTENSITY (F)

(WMM 90)

(degrees)

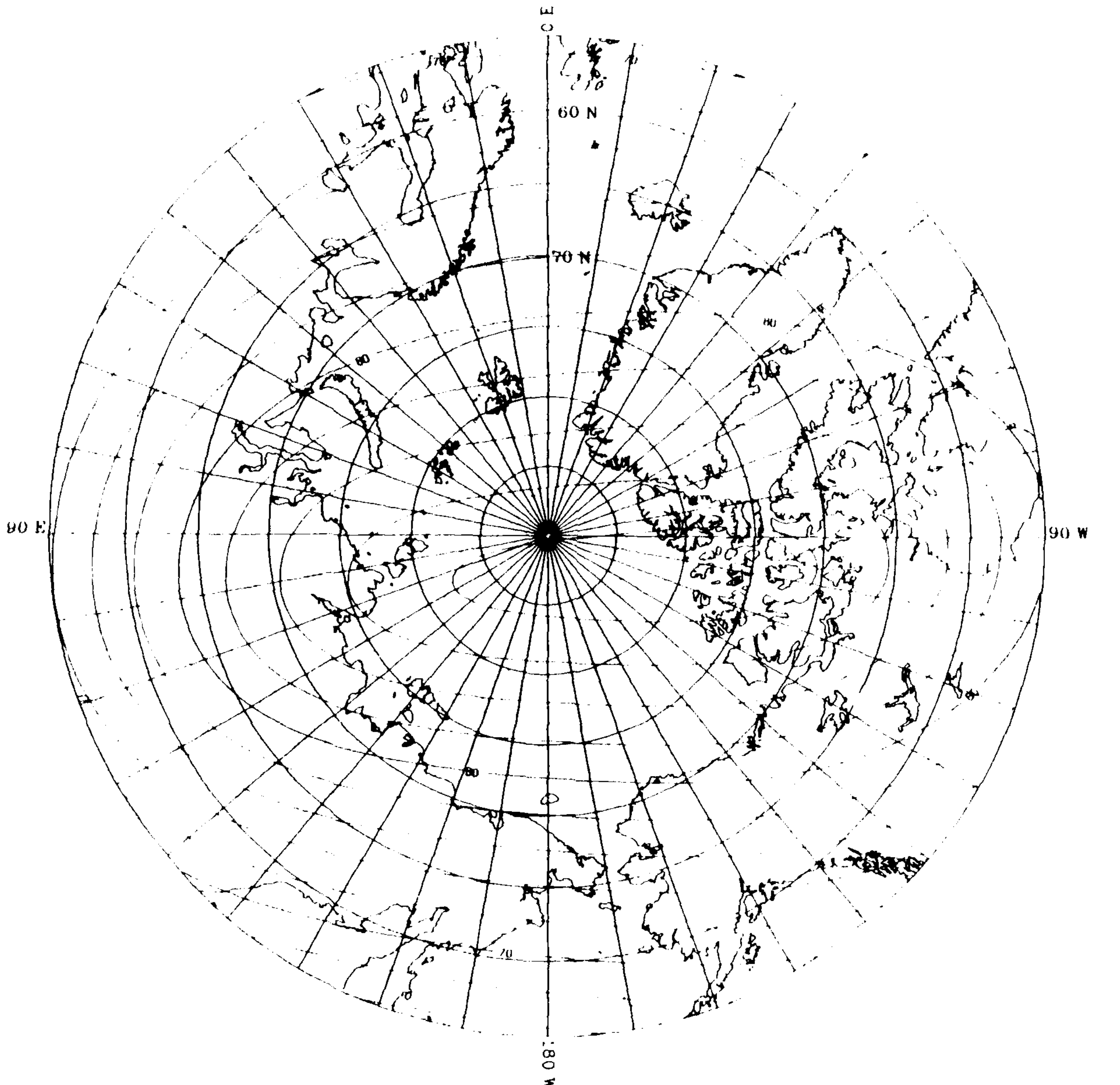


1990.0 at surface of WGS-84 reference ellipsoid

U.S. NAVAL OCEANOGRAPHIC OFFICE

CHART 21. DECLINATION (*D*)

(WMM-90) (degrees)



1990.0 at surface of WGS-84 reference ellipsoid.

U.S. NAVAL OCEANOGRAPHIC OFFICE

CHART 22. INCLINATION (I)

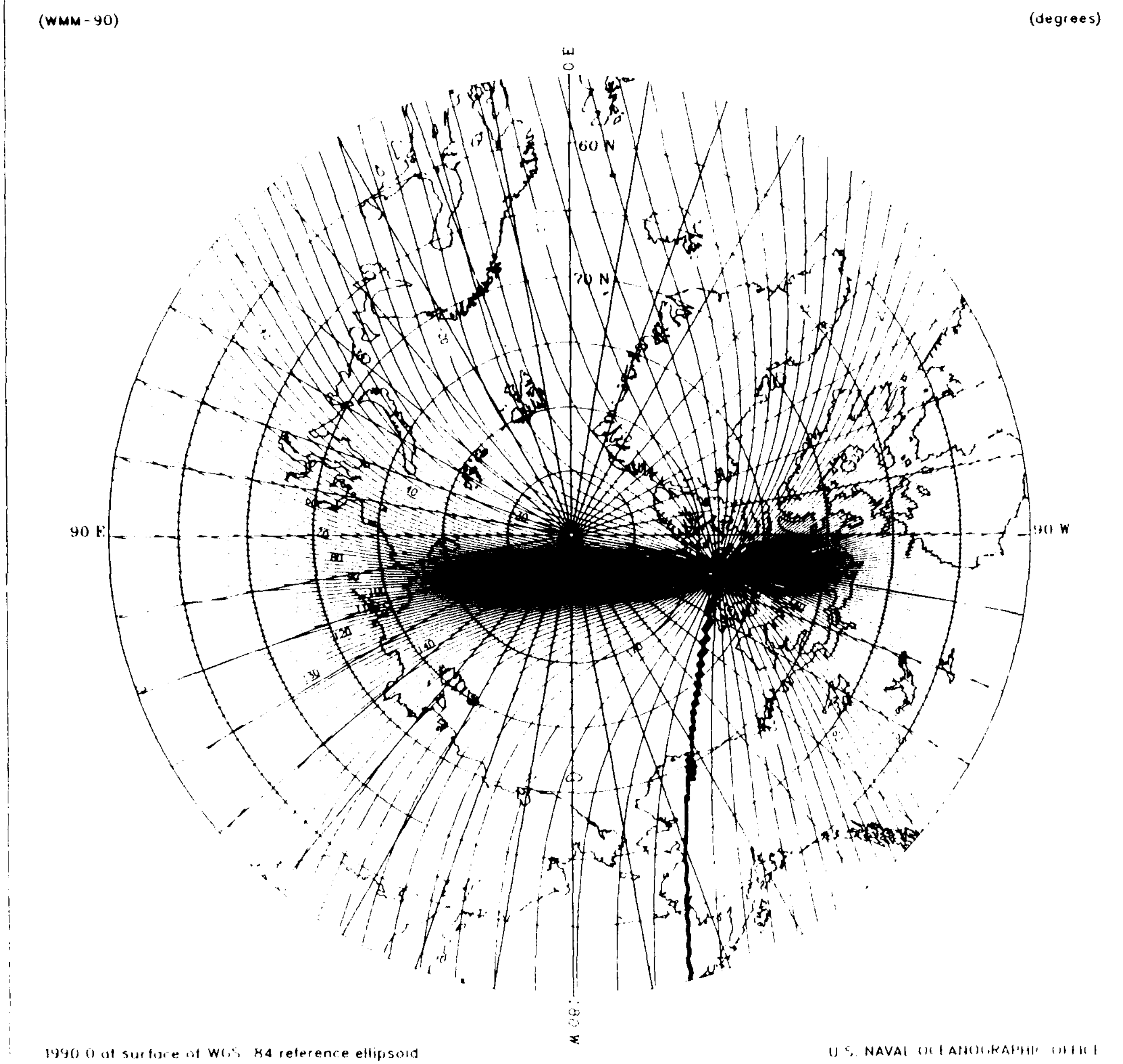


CHART 23. GRID VARIATION (GV)

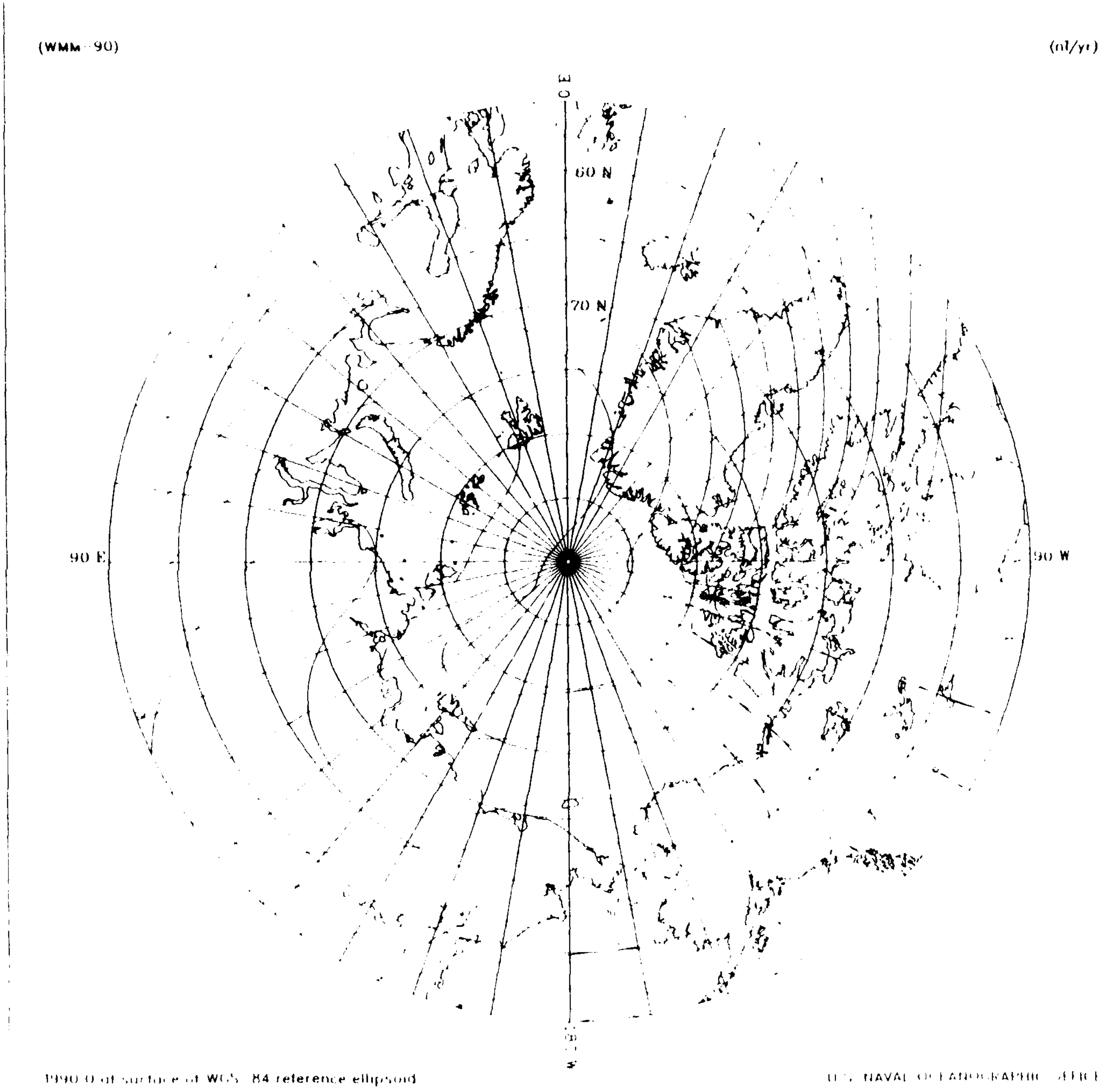


CHART 24. HORIZONTAL INTENSITY (H)

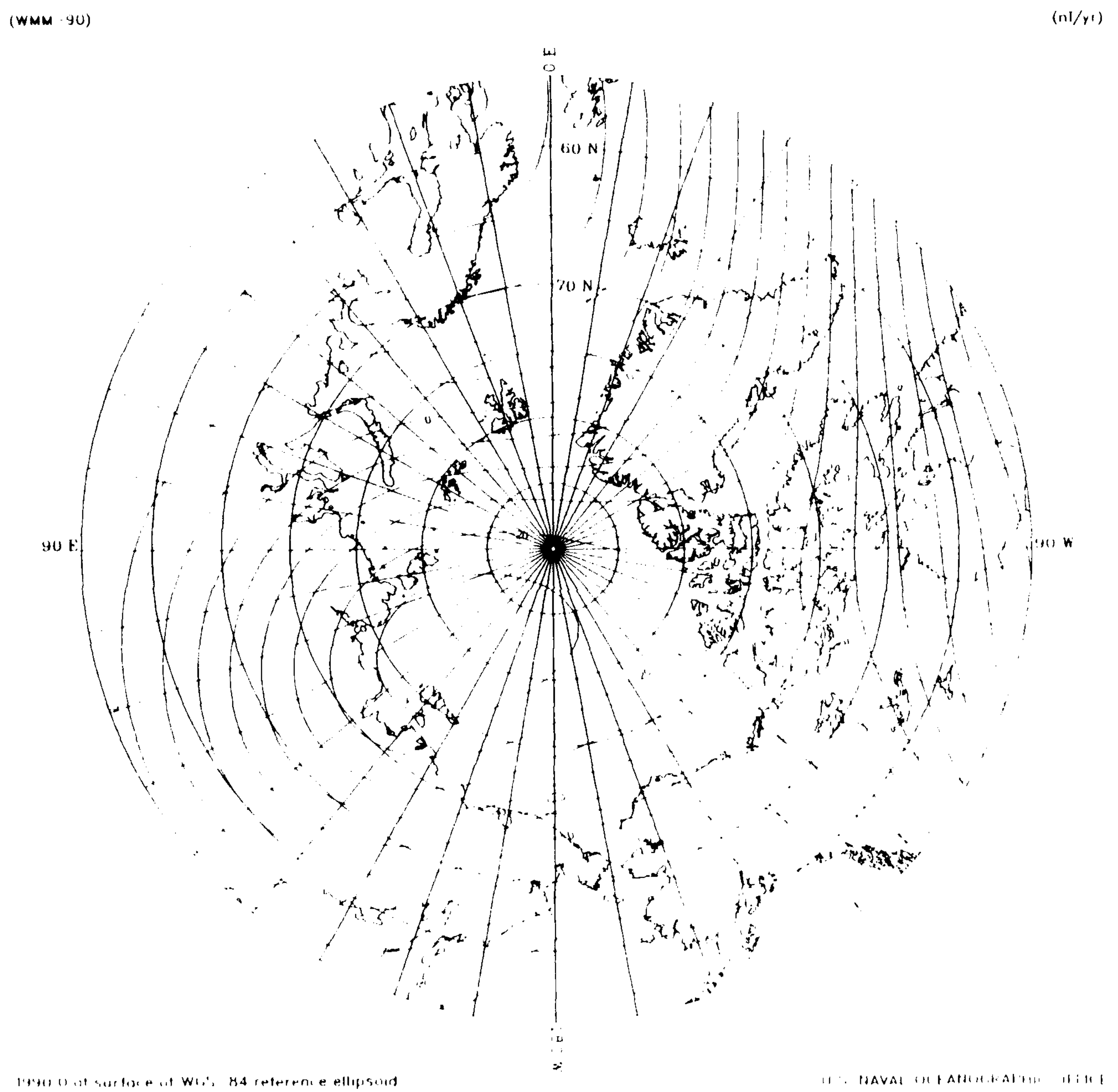
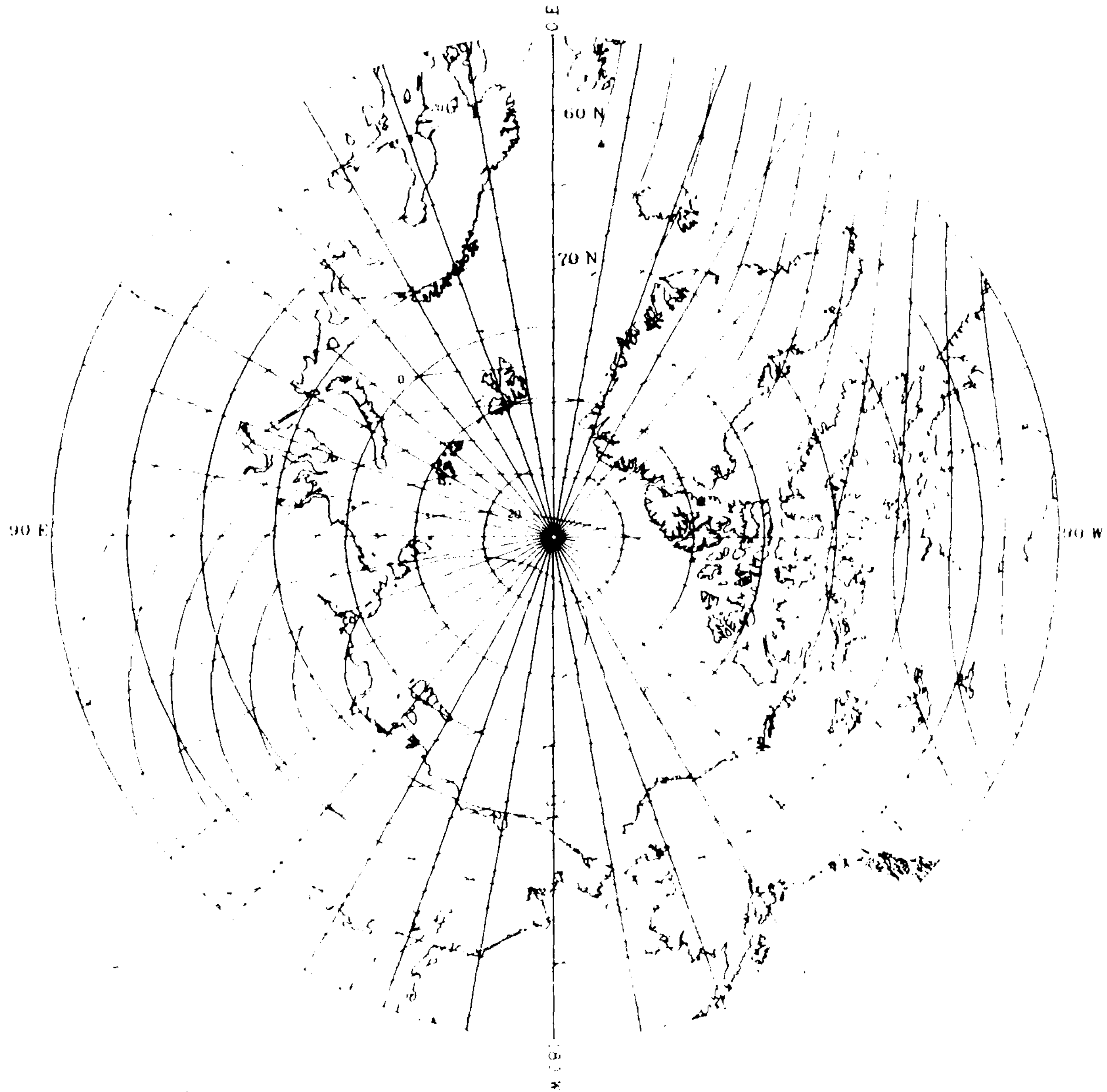


CHART 25. VERTICAL COMPONENT ($\dot{Z}$)

(WMM 90)

(nT/yr)



Height of surface of WGS-84 reference ellipsoid

U.S. NAVAL OCEANOGRAPHIC OFFICE

CHART 26. TOTAL INTENSITY ($\dot{F}$)

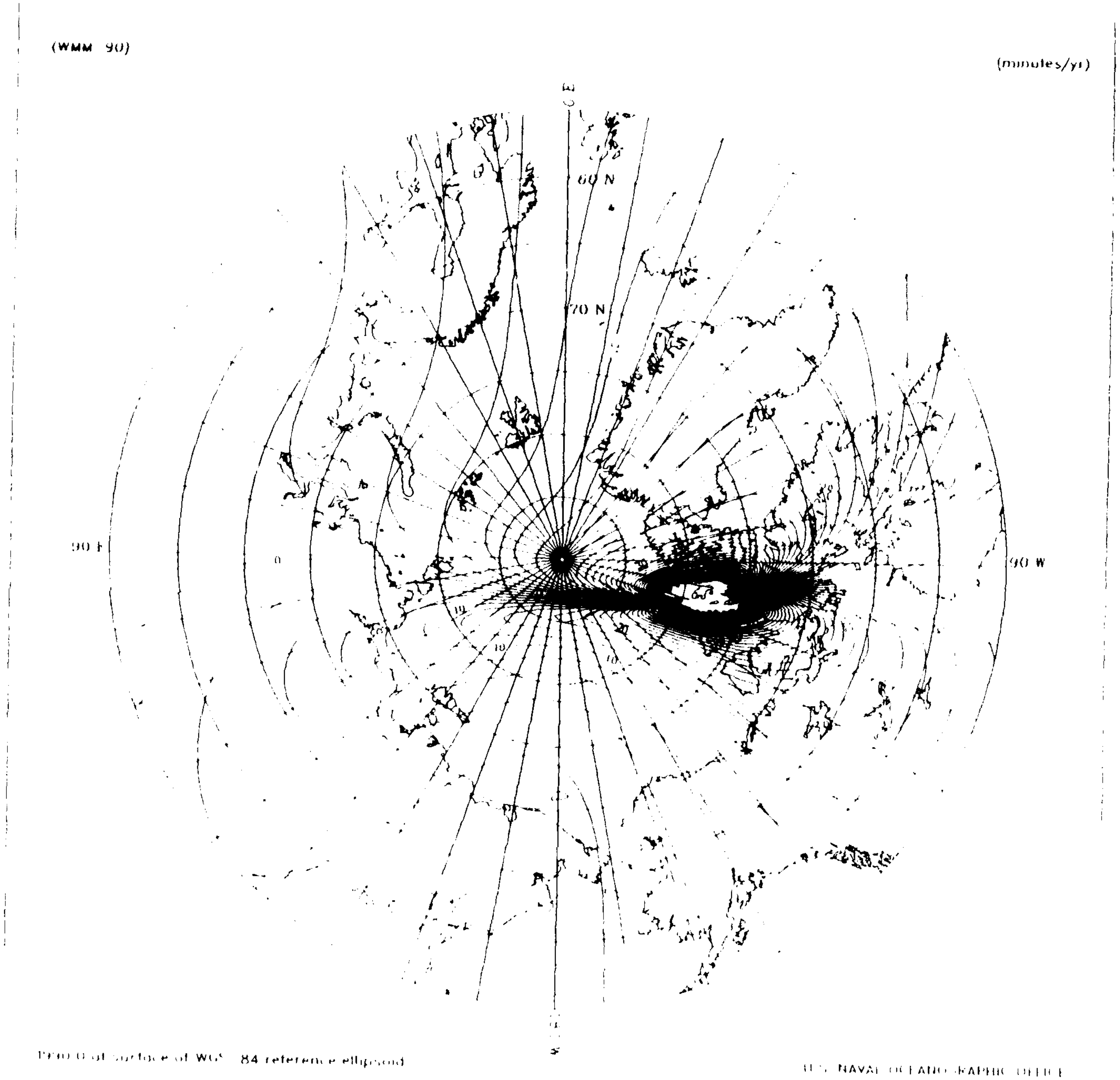


CHART 27. DECLINATION ($\dot{D}$)

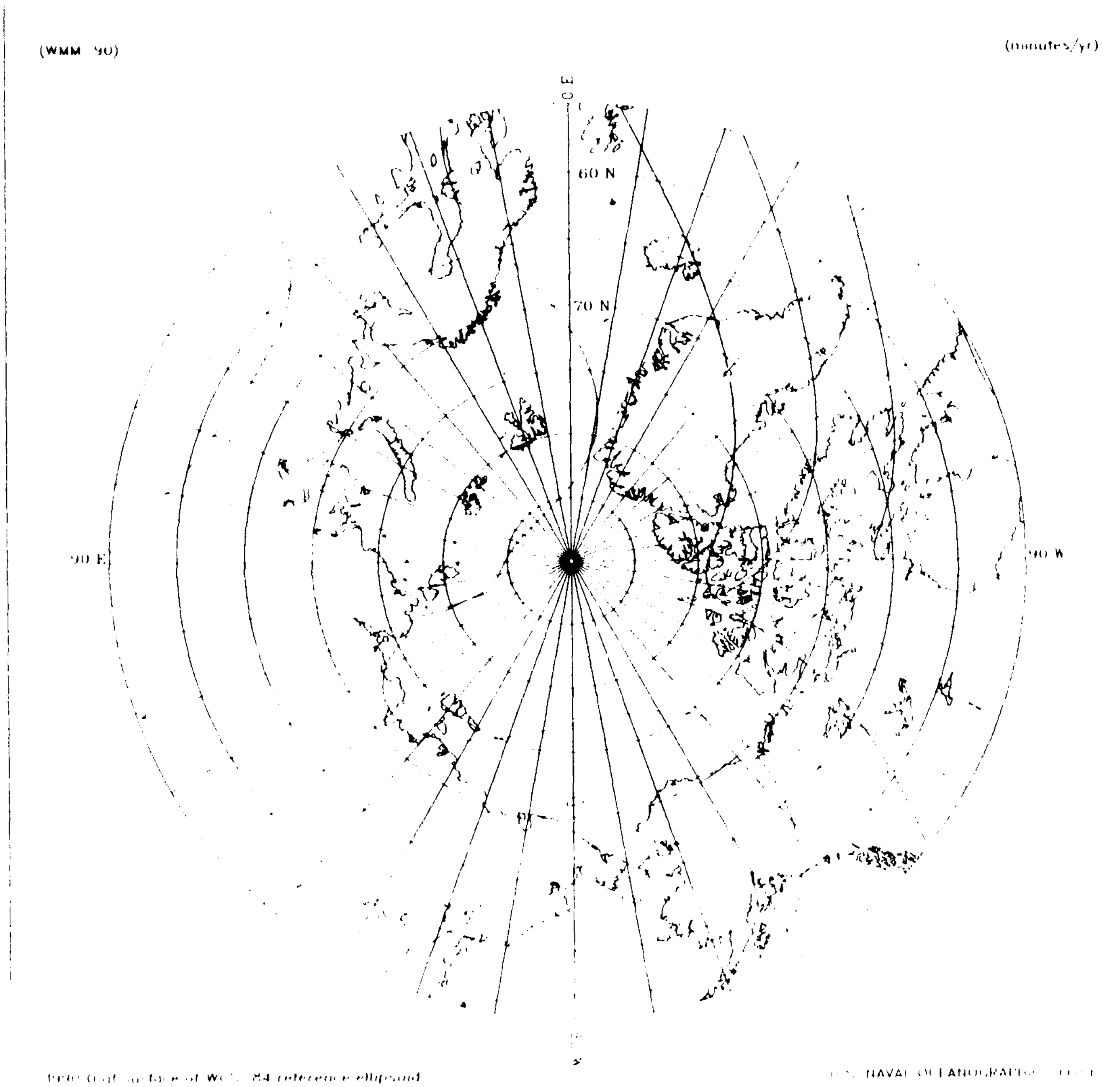


CHART 28. INCLINATION ($\dot{I}$)

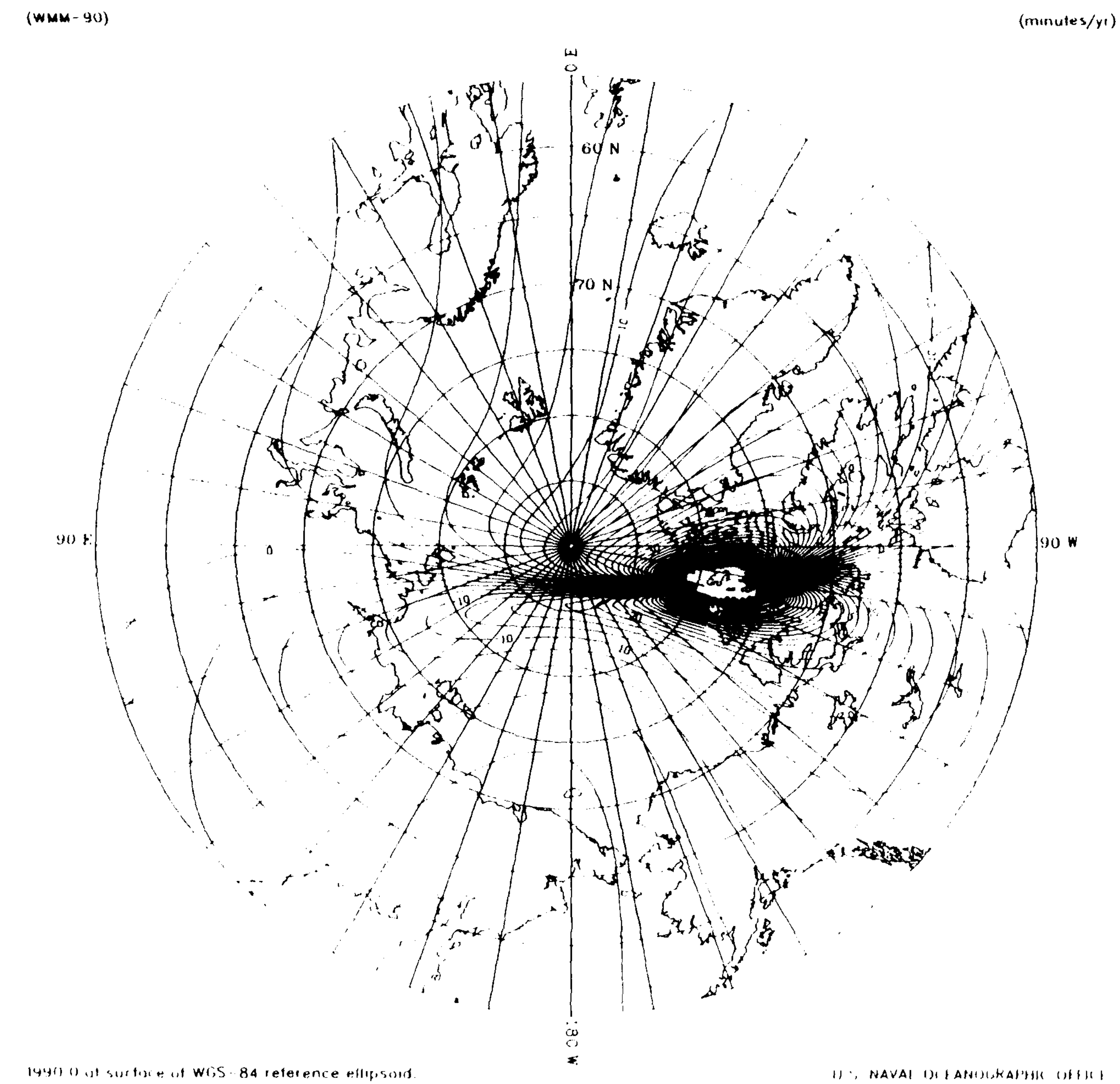


CHART 29. GRID VARIATION ($\dot{GV}$)

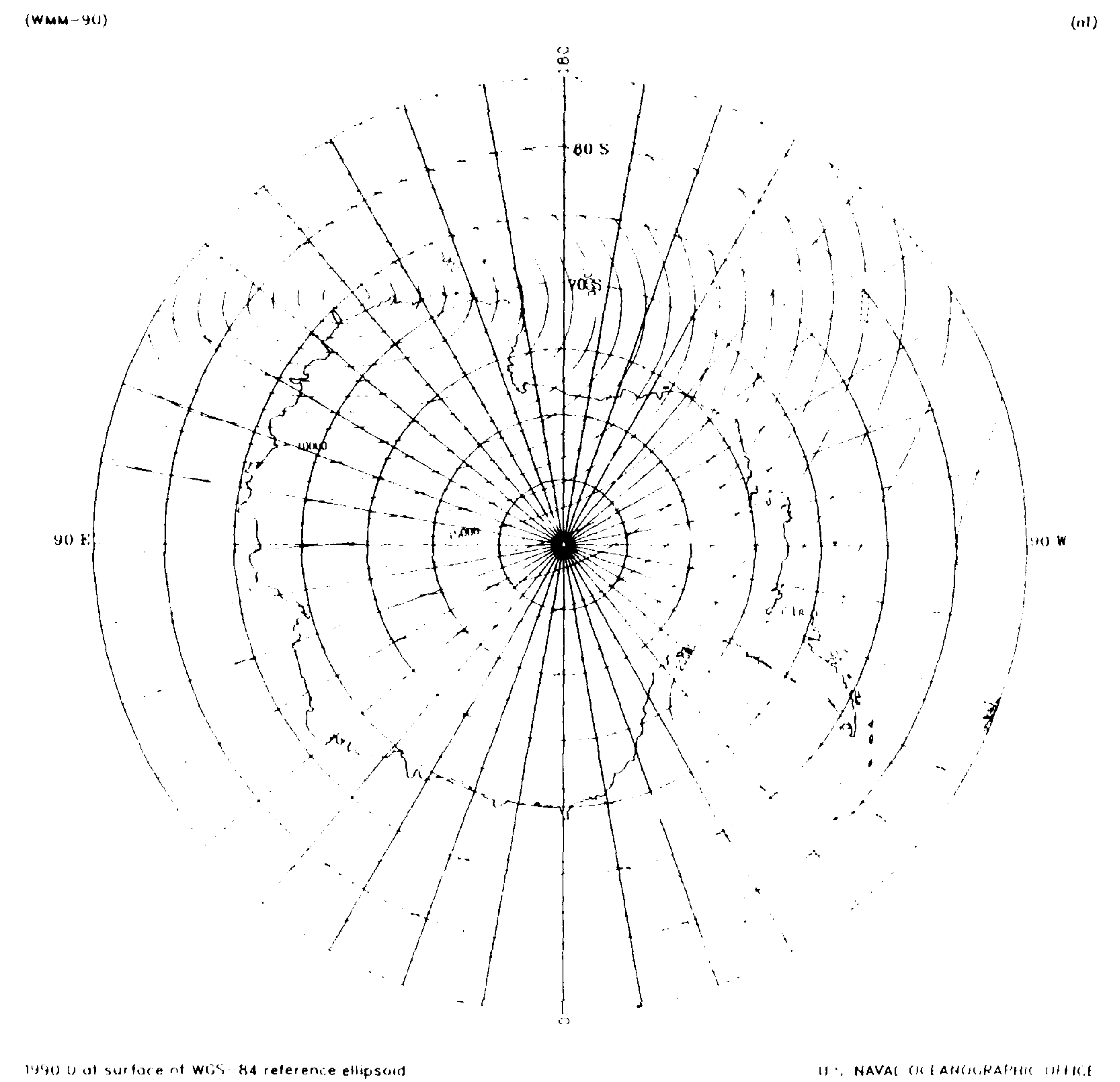


CHART 30. HORIZONTAL INTENSITY (H)

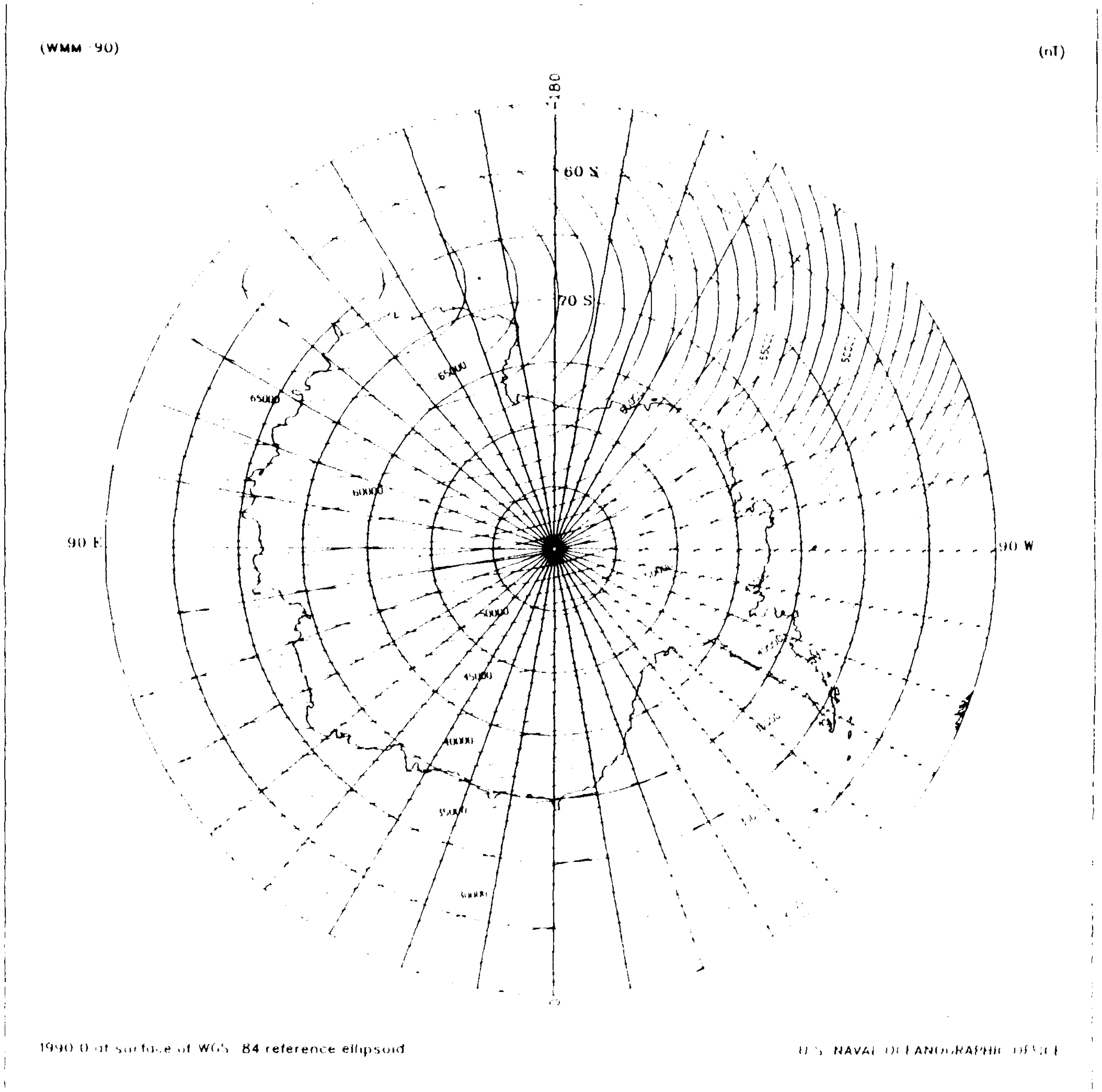
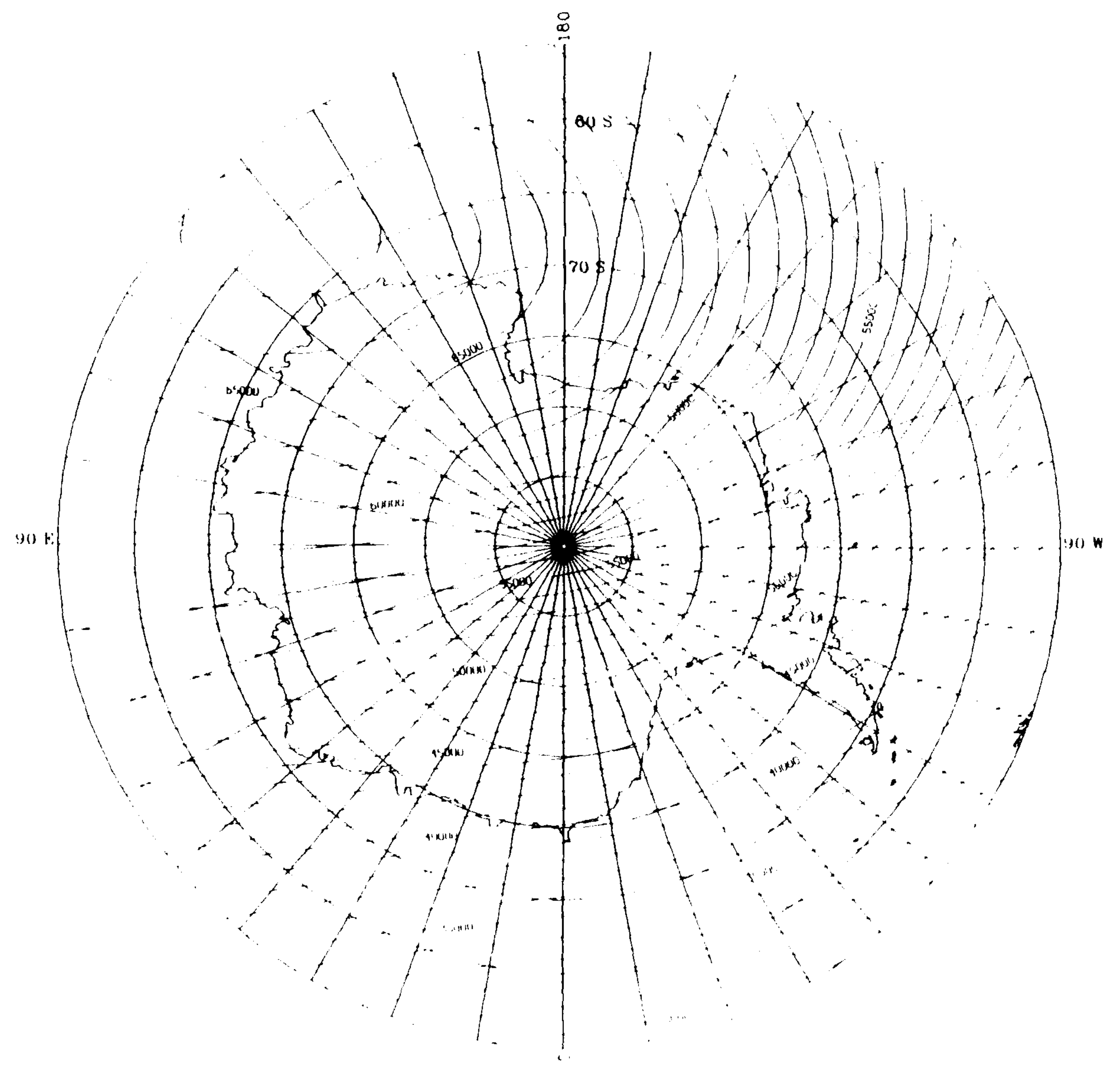


CHART 31. VERTICAL COMPONENT (Z)

(WMM-90)

(nT)

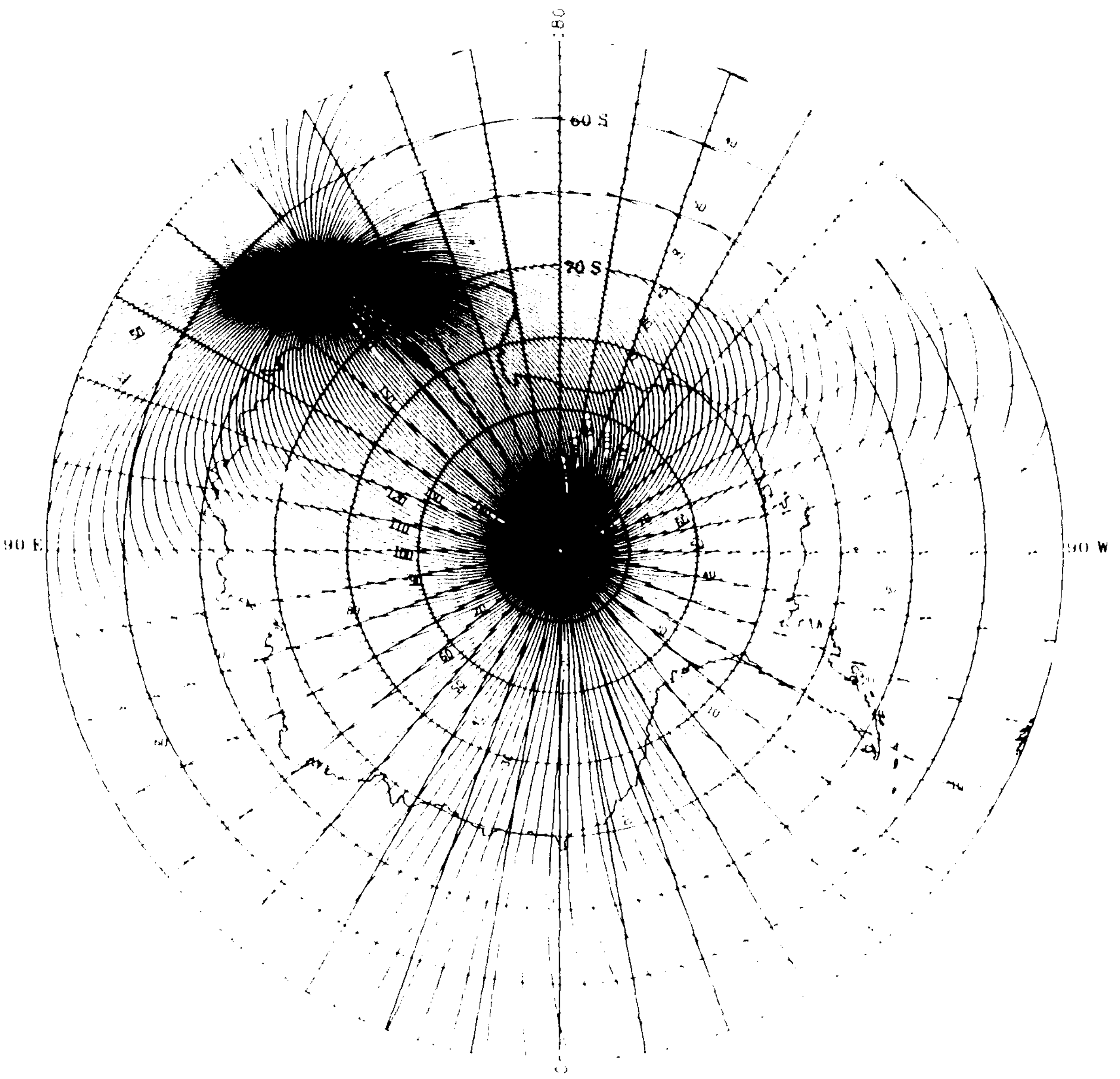


1990.0 at surface of WGS-84 reference ellipsoid

U.S. NAVAL OCEANOGRAPHIC OFFICE

CHART 22. TOTAL INTENSITY (F)

(WMM-90) (degrees)



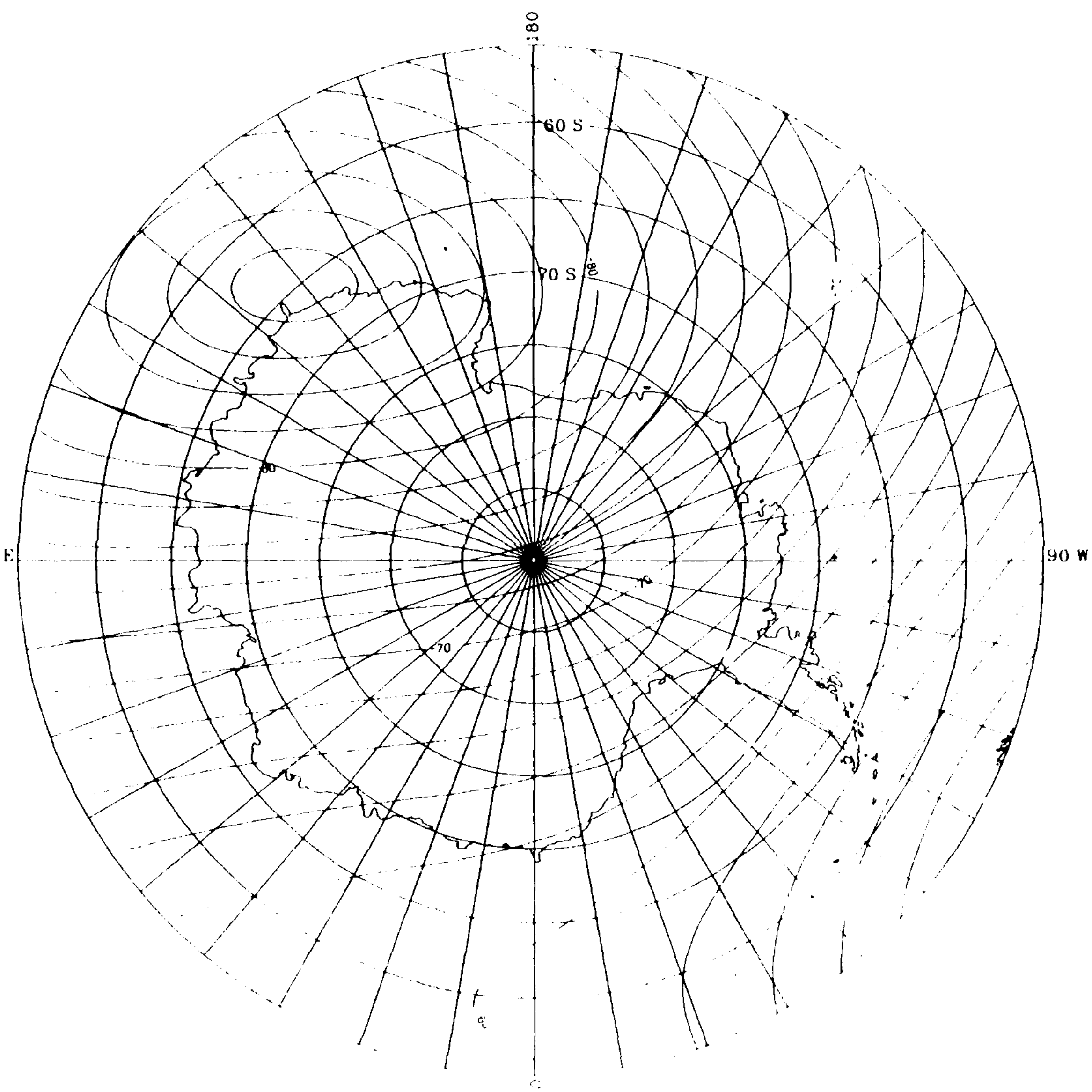
1990.0 at surface of WGS 84 reference ellipsoid

U.S. NAVAL OCEANOGRAPHIC OFFICE

CHART 33. DECLINATION (*D*)

(WMM-90)

(degrees)



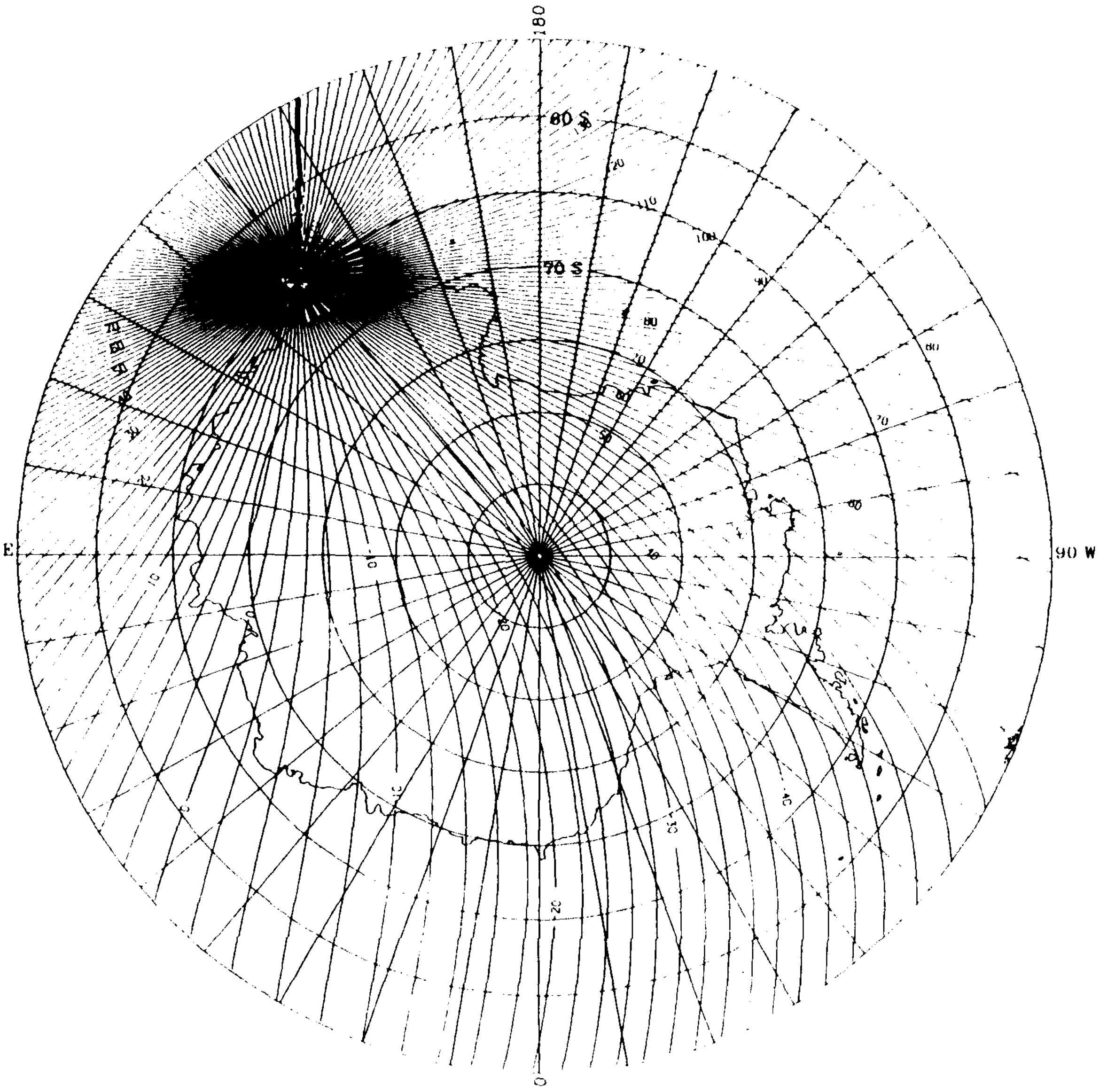
1990.0 at surface of WGS-84 reference ellipsoid

U.S. NAVAL OCEANOGRAPHIC OFFICE

CHART 34. INCLINATION (*I*)

(WMM-90)

(degrees)

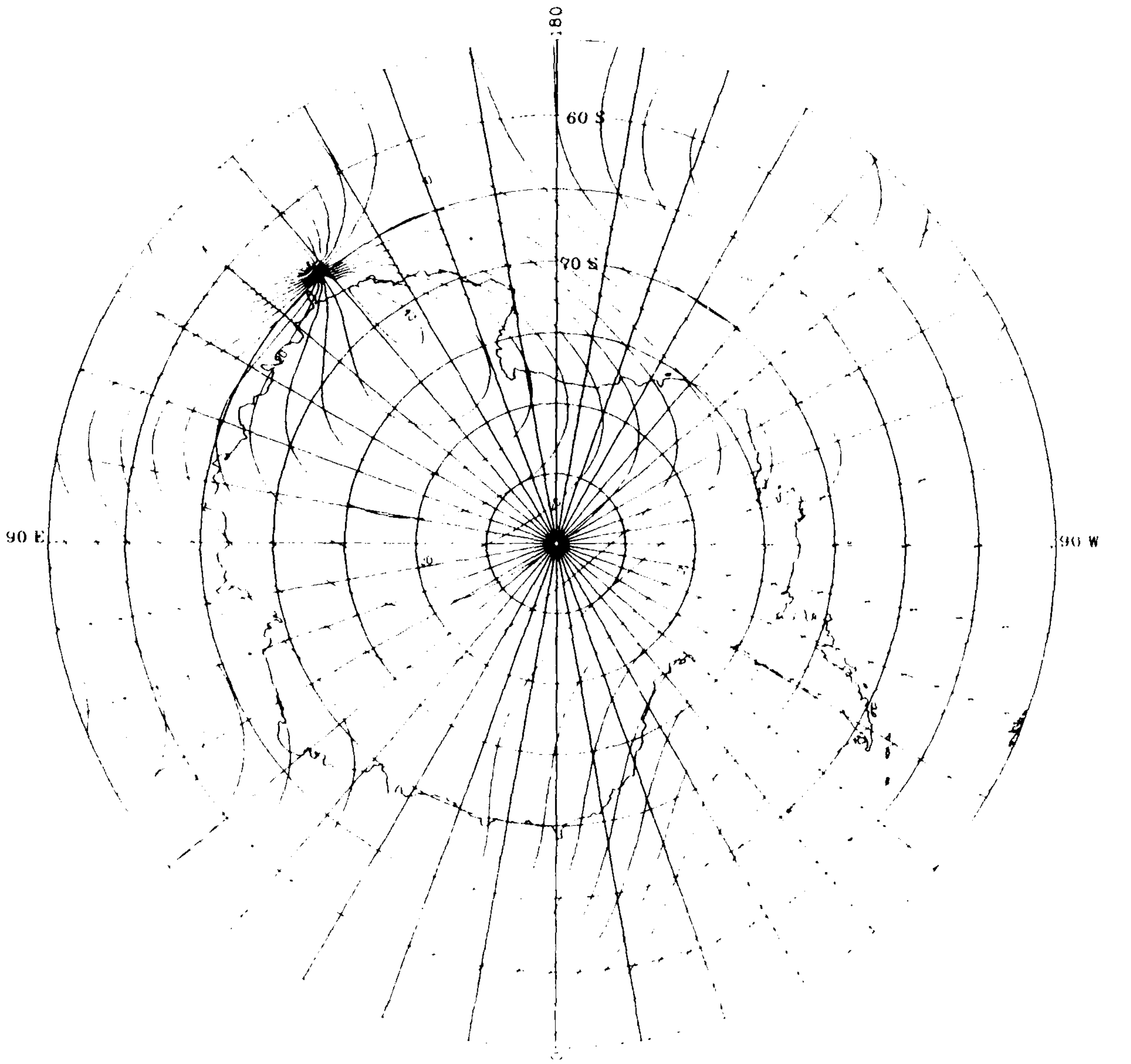


1990.0 at surface of WGS 84 reference ellipsoid.

U.S. NAVAL OCEANOGRAPHIC OFFICE

CHART 35. GRID VARIATION (*GV*)

(WMM-90) (nT/yr)



1990.0 at surface of WGS 84 reference ellipsoid

U.S. NAVAL OCEANOGRAPHIC OFFICE

CHART 36. HORIZONTAL INTENSITY (H)

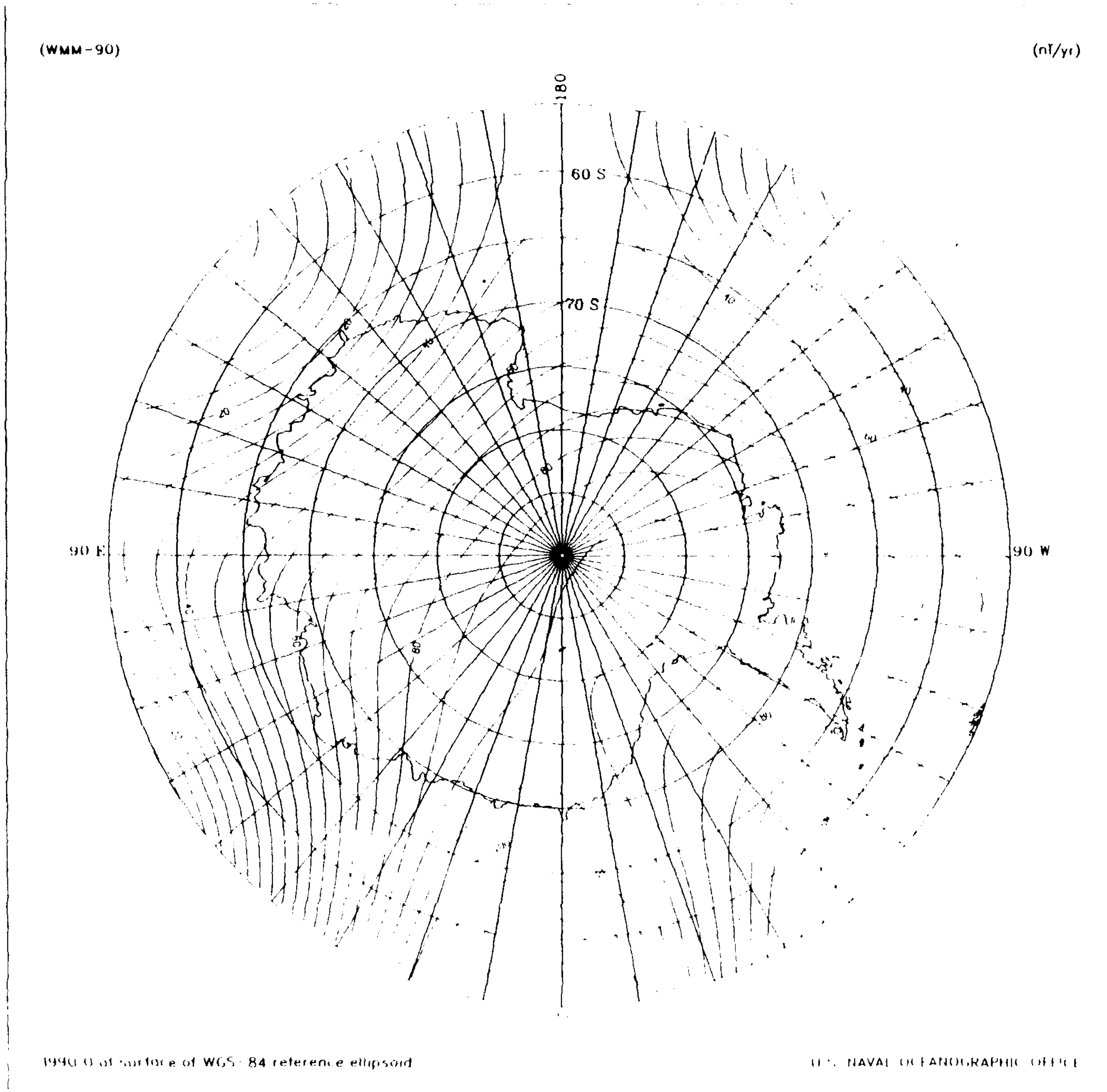


CHART 37. VERTICAL COMPONENT ($\dot{Z}$)

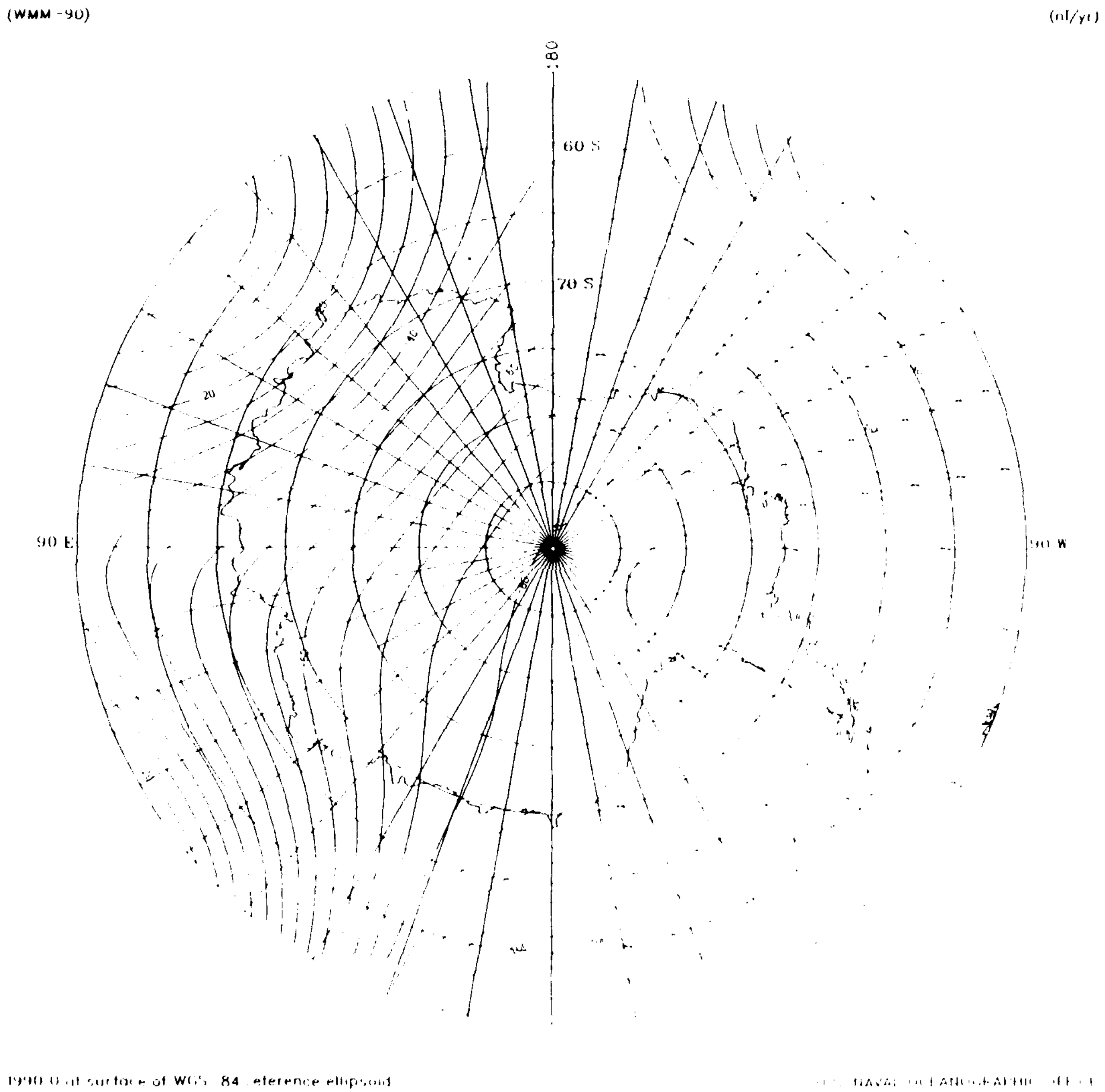


CHART 38. TOTAL INTENSITY ($\dot{F}$)

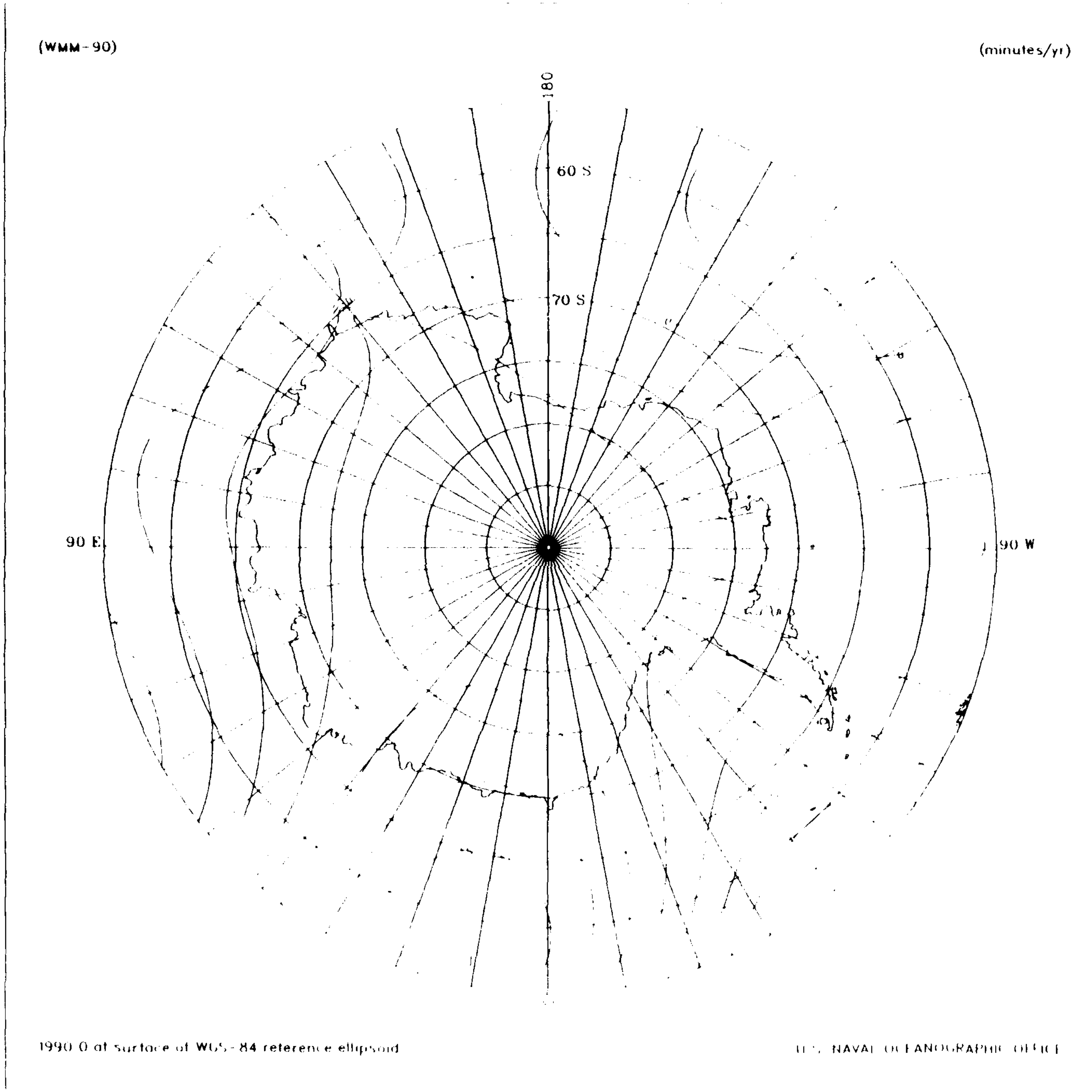
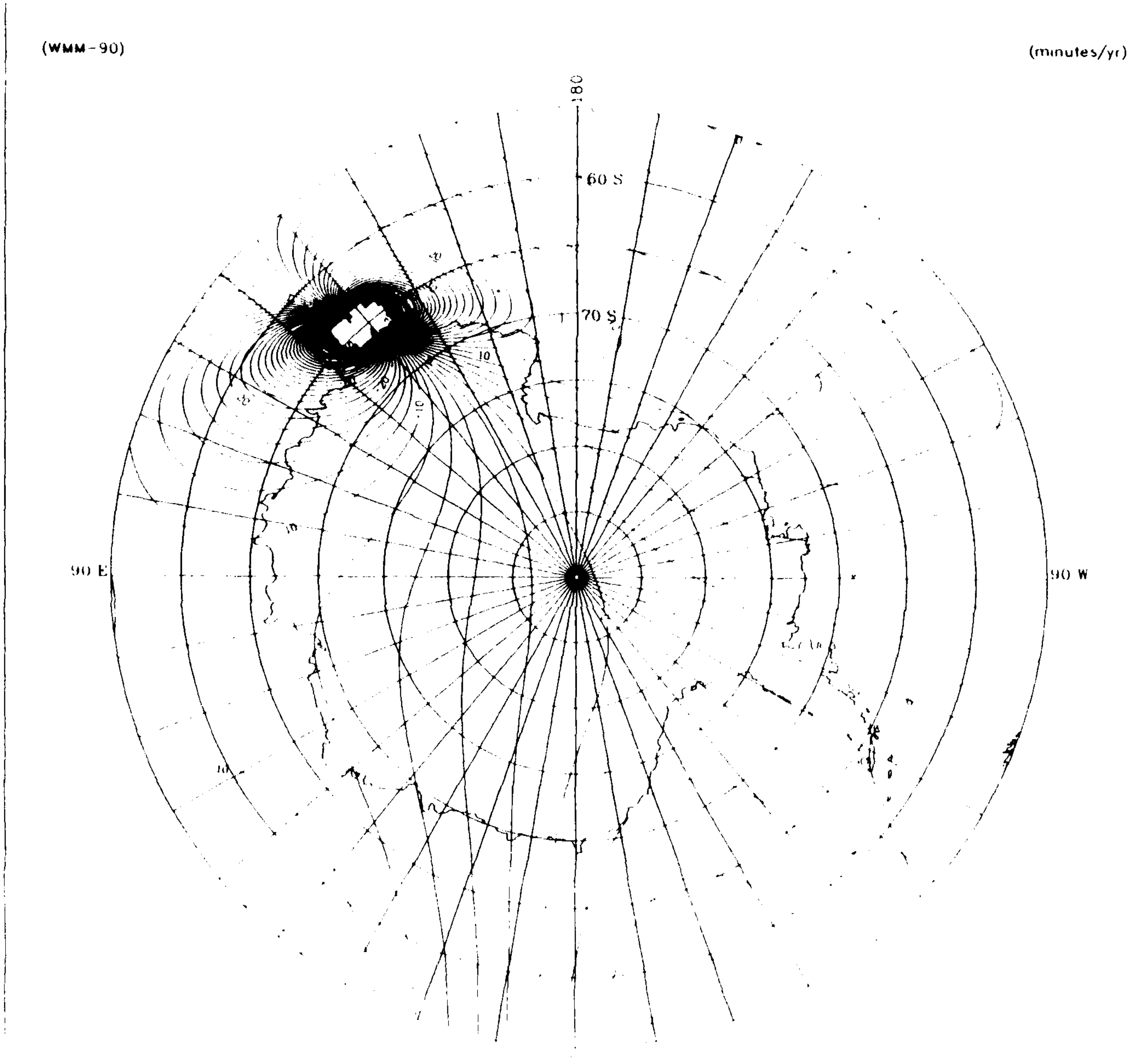


CHART 39. DECLINATION ($\dot{D}$)



1990.0 at surface of WGS 84 reference ellipsoid

U.S. NAVAL OCEANOGRAPHIC OFFICE

CHART 40. INCLINATION ($\dot{I}$)

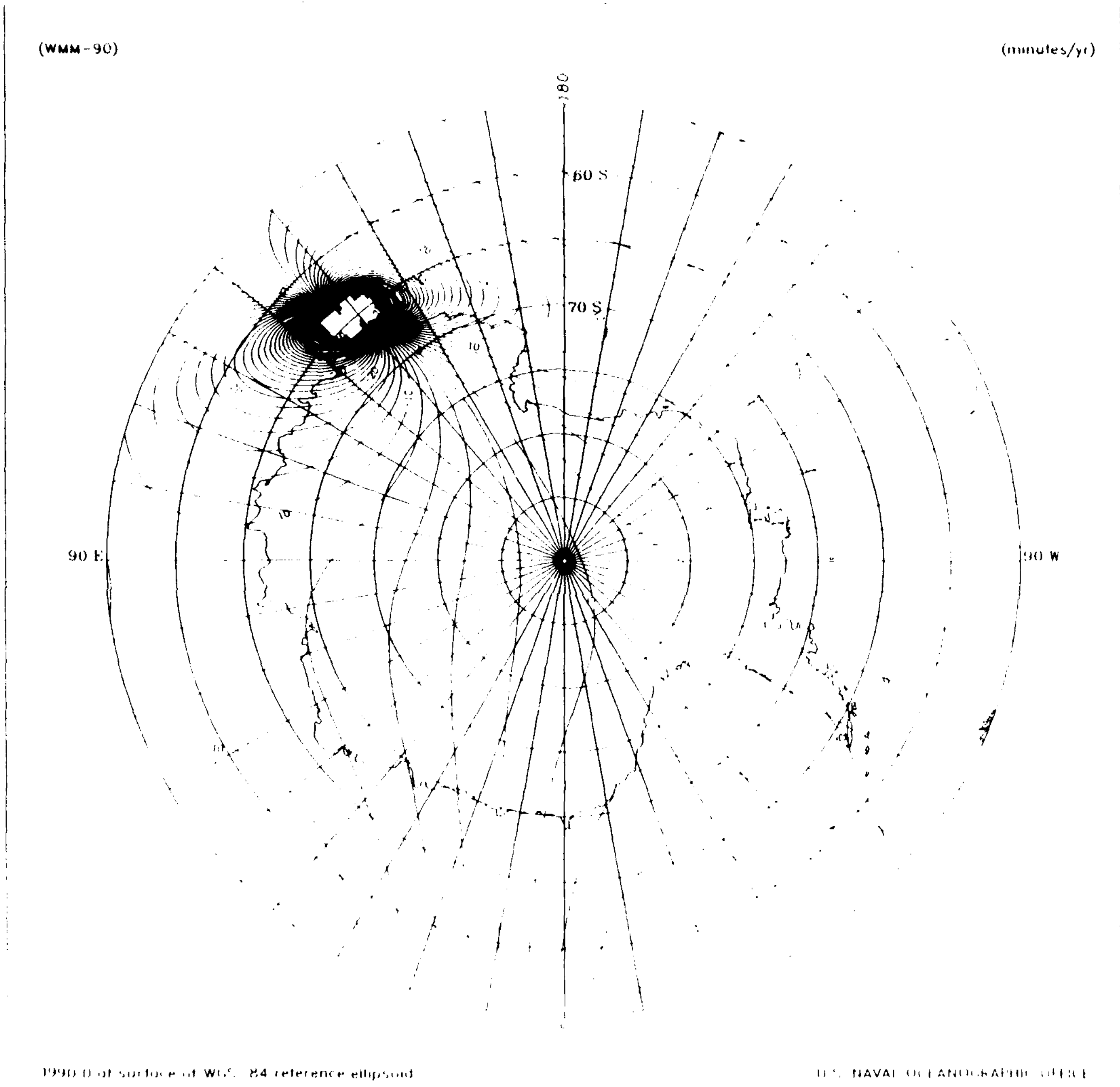


CHART 41. GRID VARIATION ($\dot{GV}$)

REFERENCES

Cain, Joseph C., et al.; A Proposed Model for the International Geomagnetic Reference Field 1965, Journal of Geomagnetism and Geoelectricity, Vol. 19, No. 4, pp. 335-355, 1967. (see appendix)

Department of Defense World Geodetic System 1984, Technical Report TR 8350.2, Defense Mapping Agency, 1987.

Langel, Robert A.; The Main Field in Geomagnetism, Vol. 1, Chapter 4, edited by J.A. Jacobs, Academic Press, New York, pp. 249-512, 1987.

Langel, Robert A. and R. H. Estes; The near-Earth magnetic field at 1980 determined from MAGSAT data, J. Geophys. Res. 90, pp. 2495-2509, 1985.

Quinn, John M., David J. Kerridge, and David R. Baraclough; World Magnetic Charts for 1985 - spherical harmonic models of the geomagnetic field and its secular variation, Geophys. J.R. Astr. Soc. Vol. 87, pp. 1143-1157, 1986.

Zmuda, Alfred J.; World Magnetic Survey 1957-1969, International Association of Geomagnetism and Aeronomy (IAGA) Bulletin #28, pp. 186-188, 1971.

APPENDIX

FORTRAN LISTING OF SUBROUTINE GEOMAG
WITH
THE WMM-90 MODEL COEFFICIENTS

```
C*****************************************************************************
C
C
C     SUBROUTINE GEOMAG (GEOMAGNETIC FIELD COMPUTATION)
C
C
C*****************************************************************************
C
C
C     WMM-90 is a proposed Defense Mapping Agency (DMA) standard product.
C     For information on the use and applicability of this product contact:
C
C              DIRECTOR
C              DEFENSE MAPPING AGENCY/HEADQUARTERS
C              ATTN: CODE PR
C              8613 LEE HIGHWAY
C              FAIRFAX, VA 22031-2137
C
C
C*****************************************************************************
C
C     GEOMAG PROGRAMMED BY:
C
C              JOHN M. QUINN  7/19/90
C              GEOPOTENTIAL DIVISION, CODE GGM
C              U.S. NAVAL OCEANOGRAPHIC OFFICE (NAVOCEANO)
C              STENNIS SPACE CENTER (SSC), MS 39522-5001
C              PHONE:          COM:   (601) 688-4252
C                               AV:         485-4252
C                              FAX:   (601) 688-5701
C
C
C*****************************************************************************
C
C
C     PURPOSE:  THIS ROUTINE COMPUTES THE DECLINATION (DEC),
C           INCLINATION (DIP), TOTAL INTENSITY (TI), AND
C           GRID VARIATION (GV - POLAR REGIONS USING A POLAR
C           STEREOGRAPHIC PROJECTION ONLY) OF THE
C           EARTH'S MAGNETIC FIELD IN GEODETIC COORDINATES
C           FROM THE COEFFICIENTS OF THE CURRENT OFFICIAL
C           DEPARTMENT OF DEFENSE (DOD) SPHERICAL HARMONIC WORLD
C           MAGNETIC MODEL (WMM-90).  THE WMM SERIES OF MODELS IS
C           UPDATED EVERY 5 YEARS ON 1 JANUARY OF THOSE YEARS
C           WHICH ARE DIVISIBLE BY 5 (I.E., 1980, 1985, 1990, ETC.)
C           BY THE U.S. NAVAL OCEANOGRAPHIC OFFICE IN COOPERATION
C           WITH THE BRITISH GEOLOGICAL SURVEY (BGS) AND
C           IS BASED ON GEOMAGNETIC SURVEY MEASUREMENTS FROM
C           AIRCRAFT, SATELLITE, AND GEOMAGNETIC OBSERVATORIES.
C
C*****************************************************************************
```

```
C
C
C     MODEL: THE WMM SERIES GEOMAGNETIC MODELS ARE COMPOSED
C            OF TWO PARTS: THE MAIN FIELD MODEL, WHICH IS
C            VALID AT THE BASE EPOCH OF THE CURRENT MODEL, AND
C            A SECULAR VARIATION MODEL, WHICH ACCOUNTS FOR SLOW
C            TEMPORAL VARIATIONS IN THE MAIN GEOMAGNETIC FIELD
C            FROM THE BASE EPOCH TO A MAXIMUM OF 5 YEARS BEYOND
C            THE BASE EPOCH. FOR EXAMPLE, THE BASE EPOCH OF
C            THE WMM-90 MODEL IS 1990.0. THIS MODEL IS THEREFORE
C            CONSIDERED VALID BETWEEN 1990.0 AND 1995.0. THE
C            COMPUTED MAGNETIC PARAMETERS ARE REFERENCED TO THE
C            WGS-84 ELLIPSOID.
C
C
C**************************************************************************
C
C
C     ACCURACY: IN OCEAN AREAS AT THE EARTH'S SURFACE OVER THE
C               ENTIRE 5-YEAR LIFE OF A DEGREE AND ORDER 12
C               SPHERICAL HARMONIC MODEL SUCH AS WMM-90, THE RMS
C               DECLINATION ERROR IS ESTIMATED TO BE < .5 DEGREES,
C               AND THE RMS INCLINATION ERROR IS ESTIMATED TO BE
C               < .5 DEGREES. ALSO, THE RMS TOTAL INTENSITY ERROR
C               IS ESTIMATED TO BE < 200 NANOTESLAS.
C
C               THE ACCURACY AT ANY GIVEN TIME OF ALL FOUR
C               GEOMAGNETIC PARAMETERS DEPENDS ON THE GEOMAGNETIC
C               LATITUDE. THE ERRORS ARE LEAST AT THE EQUATOR AND
C               GREATEST AT THE MAGNETIC POLES.
C
C               IT IS VERY IMPORTANT TO NOTE THAT A DEGREE AND
C               ORDER 12 MODEL, SUCH AS WMM-90, DESCRIBES ONLY
C               THE LONG WAVELENGTH SPATIAL MAGNETIC FLUCTUATIONS
C               DUE TO EARTH'S CORE. NOT INCLUDED IN THE WMM SERIES
C               MODELS ARE INTERMEDIATE AND SHORT WAVELENGTH
C               SPATIAL FLUCTUATIONS OF THE GEOMAGNETIC FIELD
C               WHICH ORIGINATE IN THE EARTH'S MANTLE AND CRUST.
C               CONSEQUENTLY, ISOLATED ANGULAR RESIDUALS AT VARIOUS
C               POSITIONS ON THE SURFACE (PRIMARILY OVER LAND, IN
C               CONTINENTAL MARGINS, AND OVER OCEANIC SEAMOUNTS,
C               RIDGES, AND TRENCHES) OF SEVERAL DEGREES MAY BE
C               EXPECTED. ALSO NOT INCLUDED IN THE MODEL ARE
C               NONSECULAR TEMPORAL FLUCTUATIONS OF THE GEOMAGNETIC
C               FIELD OF MAGNETOSPHERIC AND IONOSPHERIC ORIGIN.
C               DURING MAGNETIC STORMS, TEMPORAL FLUCTUATIONS CAN
C               CAUSE SUBSTANTIAL DEVIATIONS OF THE GEOMAGNETIC
C               FIELD FROM MODEL VALUES. IN ARCTIC AND ANTARCTIC
C               REGIONS, AS WELL AS IN EQUATORIAL REGIONS, DEVIATIONS
C               FROM MODEL VALUES ARE BOTH FREQUENT AND PERSISTENT.
C
```

```
C               IF THE REQUIRED DECLINATION ACCURACY IS MORE
C               STRINGENT THAN THE WMM SERIES OF MODELS PROVIDE,
C               THE USER IS ADVISED TO REQUEST SPECIAL (REGIONAL OR
C               LOCAL) SURVEYS BE PERFORMED AND MODELS PREPARED BY
C               NAVOCEANO, WHICH OPERATES THE PROJECT MAGNET
C               AIRCRAFT AND THE POLAR ORBITING GEOMAGNETIC SURVEY
C               (POGS) SATELLITE.  REQUESTS OF THIS NATURE SHOULD
C               BE MADE THROUGH DMA AT THE ADDRESS ABOVE.
C
C
C***********************************************************************
C
C
C       USAGE:  THIS ROUTINE IS BROKEN UP INTO TWO PARTS:
C
C             A) AN INITIALIZATION MODULE, WHICH IS CALLED ONLY
C                ONCE AT THE BEGINNING OF THE MAIN (CALLING)
C                PROGRAM
C             B) A PROCESSING MODULE, WHICH COMPUTES THE MAGNETIC
C                FIELD PARAMETERS FOR EACH SPECIFIED GEODETIC
C                POSITION (ALTITUDE, LATITUDE, LONGITUDE) AND TIME
C
C             INITIALIZATION IS MADE VIA A SINGLE CALL TO THE MAIN
C             ENTRY POINT (GEOMAG), WHILE SUBSEQUENT PROCESSING
C             CALLS ARE MADE THROUGH THE SECOND ENTRY POINT (GEOMG1).
C             ONE CALL TO THE PROCESSING MODULE IS REQUIRED FOR EACH
C             POSITION AND TIME.
C
C             THE VARIABLE MAXDEG IN THE INITIALIZATION CALL IS THE
C             MAXIMUM DEGREE TO WHICH THE SPHERICAL HARMONIC MODEL
C             IS TO BE COMPUTED.  IT MUST BE SPECIFIED BY THE USER
C             IN THE CALLING ROUTINE.  NORMALLY IT IS 12 BUT IT MAY
C             BE SET LESS THAN 12 TO INCREASE COMPUTATIONAL SPEED AT
C             THE EXPENSE OF REDUCED ACCURACY.
C
C             THE PC VERSION OF THIS SUBROUTINE MUST BE COMPILED
C             WITH A FORTRAN 77 COMPATIBLE COMPILER SUCH AS THE
C             MICROSOFT OPTIMIZING FORTRAN COMPILER VERSION 4.1
C             OR LATER.
C
C
C***********************************************************************
C
C
C       REFERENCES:
C
C         JOHN M. QUINN, DAVID J. KERRIDGE, AND DAVID R. BARRACLOUGH,
C            WORLD MAGNETIC CHARTS FOR 1985 - SPHERICAL HARMONIC
C            MODELS OF THE GEOMAGNETIC FIELD AND ITS SECULAR
C            VARIATION, GEOPHYS. J. R. ASTR. SOC. (1986) Vol. 87,
C            PP. 1143-1157
```

```
C
C       DEFENSE MAPPING AGENCY TECHNICAL REPORT TR 8350.2:
C          DEPARTMENT OF DEFENSE WORLD GEODETIC SYSTEM 1984,
C          SEPT. 30 (1987)
C
C       JOSEPH C. CAIN, ET AL., A PROPOSED MODEL FOR THE
C          INTERNATIONAL GEOMAGNETIC REFERENCE FIELD - 1965,
C          J. GEOMAG. AND GEOELECT. VOL. 19, NO. 4, PP. 335-355
C          (1967) (SEE APPENDIX)
C
C       ALFRED J. ZMUDA, WORLD MAGNETIC SURVEY 1957-1969,
C          INTERNATIONAL ASSOCIATION OF GEOMAGNETISM AND
C          AERONOMY (IAGA) BULLETIN #28, PP. 186-188 (1971)
C
C
C*************************************************************************
C
C
C      PARAMETER DESCRIPTIONS:
C
C         A       - SEMIMAJOR AXIS OF WGS-84 ELLIPSOID (KM)
C         B       - SEMIMINOR AXIS OF WGS-84 ELLIPSOID (KM)
C         RE      - MEAN RADIUS OF IAU-66 ELLIPSOID (KM)
C       SNORM     - SCHMIDT NORMALIZATION FACTORS
C         C       - GAUSS COEFFICIENTS OF MAIN GEOMAGNETIC MODEL (NT)
C         CD      - GAUSS COEFFICIENTS OF SECULAR GEOMAGNETIC MODEL (NT/YR)
C         TC      - TIME ADJUSTED GEOMAGNETIC GAUSS COEFFICIENTS (NT)
C       OTIME     - TIME ON PREVIOUS CALL TO GEOMAG (YRS)
C       OALT      - GEODETIC ALTITUDE ON PREVIOUS CALL TO GEOMAG (YRS)
C       OLAT      - GEODETIC LATITUDE ON PREVIOUS CALL TO GEOMAG (DEG.)
C       OLON      - GEODETIC LONGITUDE ON PREVIOUS CALL TO GEOMAG (DEG.)
C       TIME      - COMPUTATION TIME (YRS)                            (INPUT)
C                   (E.G., 1 JULY 1985 = 1985.50)
C        ALT      - GEODETIC ALTITUDE (KM)                            (INPUT)
C       GLAT      - GEODETIC LATITUDE (DEG.)                          (INPUT)
C       GLON      - GEODETIC LONGITUDE (DEG.)                         (INPUT)
C       EPOCH     - BASE TIME OF GEOMAGNETIC MODEL (YRS)
C        DTR      - DEGREE TO RADIAN CONVERSION
C       SP(M)     - SINE OF (M*SPHERICAL COORD. LONGITUDE)
C       CP(M)     - COSINE OF (M*SPHERICAL COORD. LONGITUDE)
C         ST      - SINE OF (SPHERICAL COORD. LATITUDE)
C         CT      - COSINE OF (SPHERICAL COORD. LATITUDE)
C         R       - SPHERICAL COORDINATE RADIAL POSITION (KM)
C         CA      - COSINE OF SPHERICAL TO GEODETIC VECTOR ROTATION ANGLE
C         SA      - SINE OF SPHERICAL TO GEODETIC VECTOR ROTATION ANGLE
C         BR      - RADIAL COMPONENT OF GEOMAGNETIC FIELD (NT)
C         BT      - THETA COMPONENT OF GEOMAGNETIC FIELD (NT)
C         BP      - PHI COMPONENT OF GEOMAGNETIC FIELD (NT)
C       P(N,M)    - ASSOCIATED LEGENDRE POLYNOMIALS (UNNORMALIZED)
C       PP(N)     - ASSOCIATED LEGENDRE POLYNOMIALS FOR M=1 (UNNORMALIZED)
C      DP(N,M)    - THETA DERIVATIVE OF P(N,M) (UNNORMALIZED)
C         BX      - NORTH GEOMAGNETIC COMPONENT (NT)
C         BY      - EAST GEOMAGNETIC COMPONENT (NT)
C         BZ      - VERTICALLY DOWN GEOMAGNETIC COMPONENT (NT)
C         BH      - HORIZONTAL GEOMAGNETIC COMPONENT (NT)
C        DEC      - GEOMAGNETIC DECLINATION (DEG.)                    (OUTPUT)
C                     EAST=POSITIVE ANGLES
C                     WEST=NEGATIVE ANGLES
```

```
C       DIP        - GEOMAGNETIC INCLINATION (DEG.)                      (OUTPUT)
C                    DOWN=POSITIVE ANGLES
C                     UP=NEGATIVE ANGLES
C        TI        - GEOMAGNETIC TOTAL INTENSITY (NT)                    (OUTPUT)
C        GV        - GEOMAGNETIC GRID VARIATION (DEG.)                   (OUTPUT)
C                    REFERENCED TO GRID NORTH
C                    GRID NORTH REFERENCED TO 0 MERIDIAN
C                    OF A POLAR STEREOGRAPHIC PROJECTION
C                    (ARCTIC/ANTARCTIC ONLY)
C     MAXDEG       - MAXIMUM DEGREE OF SPHERICAL HARMONIC MODEL           (INPUT)
C     MOXORD       - MAXIMUM ORDER OF SPHERICAL HARMONIC MODEL
C
C
C***********************************************************************
C
C
C     NOTE:  THIS VERSION OF GEOMAG USES THE WMM-90 GEOMAGNETIC
C        MODEL REFERENCED TO THE WGS-84 GRAVITY MODEL ELLIPSOID
C
C
C***********************************************************************
C
C
C
C
C
C
C
C
C
C***********************************************************************
C
C
C                 INITIALIZATION MODULE
C
C
C***********************************************************************
C
C
      SUBROUTINE GEOMAG(MAXDEG)
C
C
      DIMENSION C(0:12,0:12),CD(0:12,0:12),TC(0:12,0:12)
      DIMENSION P(0:12,0:12),DP(0:12,0:12),SNORM(0:12,0:12)
      DIMENSION SP(0:12),CP(0:12),FN(0:12),FM(0:12),PP(0:12)
      REAL K(0:12,0:12)
      EQUIVALENCE (SNORM,P)
C
C
      DATA EPOCH/1990.0/
C
C
```

```
      DATA C/        0.0,  -29780.5,   -2134.3,    1312.9,     933.5,      -208.3,
     *               59.0,     76.1,      22.9,       3.6,      -3.3,        1.3,
     *               -1.3,   5407.2,   -1851.7,    3062.2,   -2244.7,      784.9,
     *              352.2,     63.7,     -62.1,       2.3,       9.5,       -2.6,
     *               -1.4,      0.1,   -2278.3,    -384.3,    1691.9,     1246.8,
     *              323.5,    246.5,      60.0,       1.3,      -1.2,       -0.9,
     *                4.5,     -2.5,       0.5,    -284.9,     291.7,     -352.4,
     *              808.6,   -421.7,    -110.8,    -181.3,      30.2,      -11.7,
     *              -10.7,     -5.6,       3.2,       0.7,     249.4,     -232.7,
     *               91.3,   -296.5,     139.2,    -162.3,       0.4,        4.7,
     *              -17.5,     10.7,      -3.6,       0.2,       0.4,       40.8,
     *              148.7,   -154.6,     -67.6,      97.4,     -37.2,       15.4,
     *                7.9,      2.2,      -3.2,       3.9,      -1.1,       -0.2,
     *              -14.7,     82.2,      70.0,     -56.2,      -1.4,       24.6,
     *              -96.0,     10.1,       5.7,      -1.4,       3.2,        0.3,
     *               -1.1,    -78.6,     -26.7,       0.1,      19.9,       17.9,
     *              -21.5,     -6.8,       1.9,       3.0,       6.3,        1.7,
     *               -0.3,      0.9,       9.7,     -19.3,       6.6,      -20.1,
     *               13.4,      9.8,     -19.0,      -9.1,      -7.0,        0.8,
     *                3.0,      0.9,      -0.6,     -21.9,      14.3,        9.5,
     *               -6.7,     -6.4,       9.1,       8.9,      -8.0,        2.1,
     *               -5.5,      3.7,      -1.1,       0.8,       2.6,        1.2,
     *                2.6,      5.7,      -4.0,      -0.4,      -1.7,        3.8,
     *               -0.8,     -6.5,       0.7,       2.4,       0.2,        0.0,
     *                1.0,     -1.6,      -2.2,       1.1,      -0.7,       -1.7,
     *               -1.5,     -1.3,      -1.1,       0.6,       3.0,        0.4,
     *                0.7,      0.7,       1.3,      -1.5,       0.3,        0.2,
     *               -1.1,      1.2,      -0.2,      -1.3,       0.6,        0.6,
     *                0.2/
C
C
      DATA CD/       0.0,    16.0,   -11.7,     2.1,    -0.8,     1.7,     0.8,     0.5,
     *               0.0,     0.0,     0.0,     0.0,     0.0,   -13.8,     9.3,     3.7,
     *              -7.6,     1.0,     0.0,     0.0,     0.0,    -1.1,     0.0,     0.0,
     *               0.0,     0.0,   -12.8,   -14.9,     1.8,     0.0,    -7.4,     0.0,
     *               1.5,    -0.9,     0.0,     0.0,     0.0,     0.0,     0.0,     3.1,
     *               0.8,   -11.3,    -5.8,     0.8,    -2.7,     0.0,     1.5,     0.0,
     *               0.0,     0.0,     0.0,     0.0,     3.3,     3.7,     2.8,     0.0,
     *              -6.4,     0.0,     0.0,     2.7,    -2.1,     0.0,     0.0,     0.0,
     *               0.0,     0.0,    -2.1,     1.2,     1.2,     0.6,     3.0,     0.0,
     *              -1.0,     0.0,     0.0,     0.0,     0.0,     0.0,    -0.6,    -0.6,
     *               0.0,    -2.3,     0.0,     0.0,     0.0,     0.0,     1.0,     0.0,
     *               0.0,     0.0,     0.0,     0.6,     0.8,     0.0,     0.0,     0.0,
     *               0.4,     0.0,     0.0,     0.0,     0.0,     0.0,     0.0,     0.0,
     *               0.4,    -0.8,     0.5,     0.3,     0.5,     0.0,    -0.7,     0.0,
     *              57*0.0/
C
C
C
C
C
```

```
C          INITIALIZE CONSTANTS
C
C
      IF (MAXDEG .GT. 12) MAXDEG=12
      MAXORD=MAXDEG
      PI=3.14159265359
      DTR=PI/180.0
      SP(0)=0.
      CP(0)=1.
      P(0,0)=1.
      PP(0)=1.
      DP(0,0)=0.
      A=6378.137
      B=6356.7523142
      RE=6371.2
      A2=A**2
      B2=B**2
      C2=A2-B2
      A4=A2**2
      B4=B2**2
      C4=A4-B4
C
C          CONVERT SCHMIDT NORMALIZED GAUSS COEFFICIENTS TO
C          UNNORMALIZED
C
      SNORM(0,0)=1.
      DO 20 N=1,MAXORD
      SNORM(N,0)=SNORM(N-1,0)*FLOAT(2*N-1)/FLOAT(N)
      J=2
      DO 10 M=0,N
      K(N,M)=FLOAT((N-1)**2-M**2)/FLOAT((2*N-1)*(2*N-3))
      IF (M .GT. 0) THEN
      FLNMJ=FLOAT((N-M+1)*J)/FLOAT(N+M)
      SNORM(N,M)=SNORM(N,M-1)*SQRT(FLNMJ)
      J=1
      C(M-1,N)=SNORM(N,M)*C(M-1,N)
      CD(M-1,N)=SNORM(N,M)*CD(M-1,N)
      ENDIF
      C(N,M)=SNORM(N,M)*C(N,M)
      CD(N,M)=SNORM(N,M)*CD(N,M)
   10 CONTINUE
      FN(N)=FLOAT(N+1)
      FM(N)=FLOAT(N)
   20 CONTINUE
      K(1,1)=0.
C
C
      OTIME=-1000.
      OALT=-1000.
      OLAT=-1000.
      OLON=-1000.
```

```
C
C
      RETURN
C
C
C*****************************************************************************
C
C
C                  PROCESSING MODULE
C
C
C*****************************************************************************
C
C
      ENTRY GEOMG1(ALT,GLAT,GLON,TIME,DEC,DIP,TI,GV)
C
C
      DT=TIME-EPOCH
      IF (OTIME .LT. 0. .AND. (DT .LT. 0. .OR. DT .GT. 5.)) THEN
      PRINT *, '     '
      PRINT *, ' WARNING - TIME EXTENDS BEYOND MODEL 5-YEAR LIFE SPAN'
      PRINT *, ' CONTACT DMA FOR PRODUCT UPDATES:'
      PRINT *, '     '
      PRINT *, '       DEFENSE MAPPING AGENCY'
      PRINT *, '       ATTN: Code PRS'
      PRINT *, '       8613 LEE HIGHWAY'
      PRINT *, '       FAIRFAX, VA 22031-2137'
      PRINT *, '       (703)285-9197, AUTOVON 356-9197'
      PRINT *, '     '
      PRINT *, ' EPOCH  = ',EPOCH
      PRINT *, ' TIME   = ',TIME
      ENDIF
C
C
      RLON=GLON*DTR
      RLAT=GLAT*DTR
      SRLON=SIN(RLON)
      SRLAT=SIN(RLAT)
      CRLON=COS(RLON)
      CRLAT=COS(RLAT)
      SRLON2=SRLON**2
      SRLAT2=SRLAT**2
      CRLON2=CRLON**2
      CRLAT2=CRLAT**2
      SP(1)=SRLON
      CP(1)=CRLON
C
        CONVERT FROM GEODETIC COORDS. TO SPHERICAL COORDS.
C
      IF (ALT .NE. OALT .OR. GLAT .NE. OLAT) THEN
      Q=SQRT(A2-C2*SRLAT2)
```

```
      Q1=ALT*Q
      Q2=((Q1+A2)/(Q1+B2))**2
      CT=SRLAT/SQRT(Q2*CRLAT2+SRLAT2)
      ST=SQRT(1.0-CT**2)
      R2=ALT**2+2.0*Q1+(A4-C4*SRLAT2)/Q**2
      R=SQRT(R2)
      D=SQRT(A2*CRLAT2+B2*SRLAT2)
      CA=(ALT+D)/R
      SA=C2*CRLAT*SRLAT/(R*D)
      ENDIF
C
C
      IF (GLON .NE. OLON) THEN
      DO 40 M=2,MAXORD
      SP(M)=SP(1)*CP(M-1)+CP(1)*SP(M-1)
      CP(M)=CP(1)*CP(M-1)-SP(1)*SP(M-1)
   40 CONTINUE
      ENDIF
C
C
      AOR=RE/R
      AR=AOR**2
C
C
      BR=0.
      BT=0.
      BP=0.
      BPP=0.
C
C
      DO 70 N=1,MAXORD
      AR=AR*AOR
      DO 60 M=0,N
C
        COMPUTE UNNORMALIZED ASSOCIATED LEGENDRE POLYNOMIALS
        AND DERIVATIVES VIA RECURSION RELATIONS
C
      IF (ALT .NE. OALT .OR. GLAT .NE. OLAT) THEN
      IF (N .EQ. M) THEN
      P(N,M)=ST*P(N-1,M-1)
      DP(N,M)=ST*DP(N-1,M-1)+CT*P(N-1,M-1)
      GO TO 50
      ENDIF
      IF (N .EQ. 1 .AND. M .EQ. 0) THEN
      P(N,M)=CT*P(N-1,M)
      DP(N,M)=CT*DP(N-1,M)-ST*P(N-1,M)
      GO TO 50
      ENDIF
      IF (N .GT. 1 .AND. N .NE. M) THEN
      IF (M .GT. N-2) P(N-2,M)=0.0
      IF (M .GT. N-2) DP(N-2,M)=0.0
```

```
      P(N,M)=CT*P(N-1,M)-K(N,M)*P(N-2,M)
      DP(N,M)=CT*DP(N-1,M)-ST*P(N-1,M)-K(N,M)*DP(N-2,M)
      ENDIF
      ENDIF
   50 CONTINUE
C
        TIME ADJUST THE GAUSS COEFFICIENTS
C
      IF (TIME .NE. OTIME) THEN
      TC(N,M)=C(N,M)+DT*CD(N,M)
      IF (M .NE. 0) THEN
      TC(M-1,N)=C(M-1,N)+DT*CD(M-1,N)
      ENDIF
      ENDIF
C
        ACCUMULATE TERMS OF THE SPHERICAL HARMONIC EXPANSIONS
C
      PAR=AR*P(N,M)
      IF (M .EQ. 0) THEN
      TEMP1=TC(N,M)*CP(M)
      TEMP2=TC(N,M)*SP(M)
      ELSE
      TEMP1=TC(N,M)*CP(M)+TC(M-1,N)*SP(M)
      TEMP2=TC(N,M)*SP(M)-TC(M-1,N)*CP(M)
      ENDIF
      BT=BT-AR*TEMP1*DP(N,M)
      BP=BP+FM(M)*TEMP2*PAR
      BR=BR+FN(N)*TEMP1*PAR
C
        SPECIAL CASE:  NORTH/SOUTH GEOGRAPHIC POLES
C
      IF (ST .EQ. 0.0 .AND. M .EQ. 1) THEN
      IF (N .EQ. 1) THEN
      PP(N)=PP(N-1)
      ELSE
      PP(N)=CT*PP(N-1)-K(N,M)*PP(N-2)
      ENDIF
      PARP=AR*PP(N)
      BPP=BPP+FM(M)*TEMP2*PARP
      ENDIF
C
C
   60 CONTINUE
   70 CONTINUE
C
C
      IF (ST .EQ. 0.0) THEN
      BP=BPP
      ELSE
      BP=BP/ST
      ENDIF
```

```
C
        ROTATE MAGNETIC VECTOR COMPONENTS FROM SPHERICAL TO
        GEODETIC COORDINATES
C
      BX=-BT*CA-BR*SA
      BY=BP
      BZ=BT*SA-BR*CA
C
        COMPUTE DECLINATION (DEC), INCLINATION (DIP), AND
        TOTAL INTENSITY (TI)
C
      BH=SQRT(BX**2+BY**2)
      TI=SQRT(BH**2+BZ**2)
      DEC=ATAN2(BY,BX)/DTR
      DIP=ATAN2(BZ,BH)/DTR
C
        COMPUTE MAGNETIC GRID VARIATION IF THE CURRENT
        GEODETIC POSITION IS IN THE ARCTIC OR ANTARCTIC
        (I.E. GLAT > +55 DEGREES OR GLAT < -55 DEGREES)
C
        OTHERWISE, SET MAGNETIC GRID VARIATION TO -999.0
C
      GV=-999.0
      IF (ABS(GLAT) .GE. 55.) THEN
      IF (GLAT .GT. 0. .AND. GLON .GE. 0.) GV=DEC-GLON
      IF (GLAT .GT. 0. .AND. GLON .LT. 0.) GV=DEC+ABS(GLON)
      IF (GLAT .LT. 0. .AND. GLON .GE. 0.) GV=DEC+GLON
      IF (GLAT .LT. 0. .AND. GLON .LT. 0.) GV=DEC-ABS(GLON)
      IF (GV .GT. +180.) GV=GV-360.
      IF (GV .LT. -180.) GV=GV+360.
      ENDIF
C
C
      OTIME=TIME
      OALT=ALT
      OLAT=GLAT
      OLON=GLON
C
C
      RETURN
C
C
      END
```

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